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ENGINEERING

An Illustrated Weekly Journal

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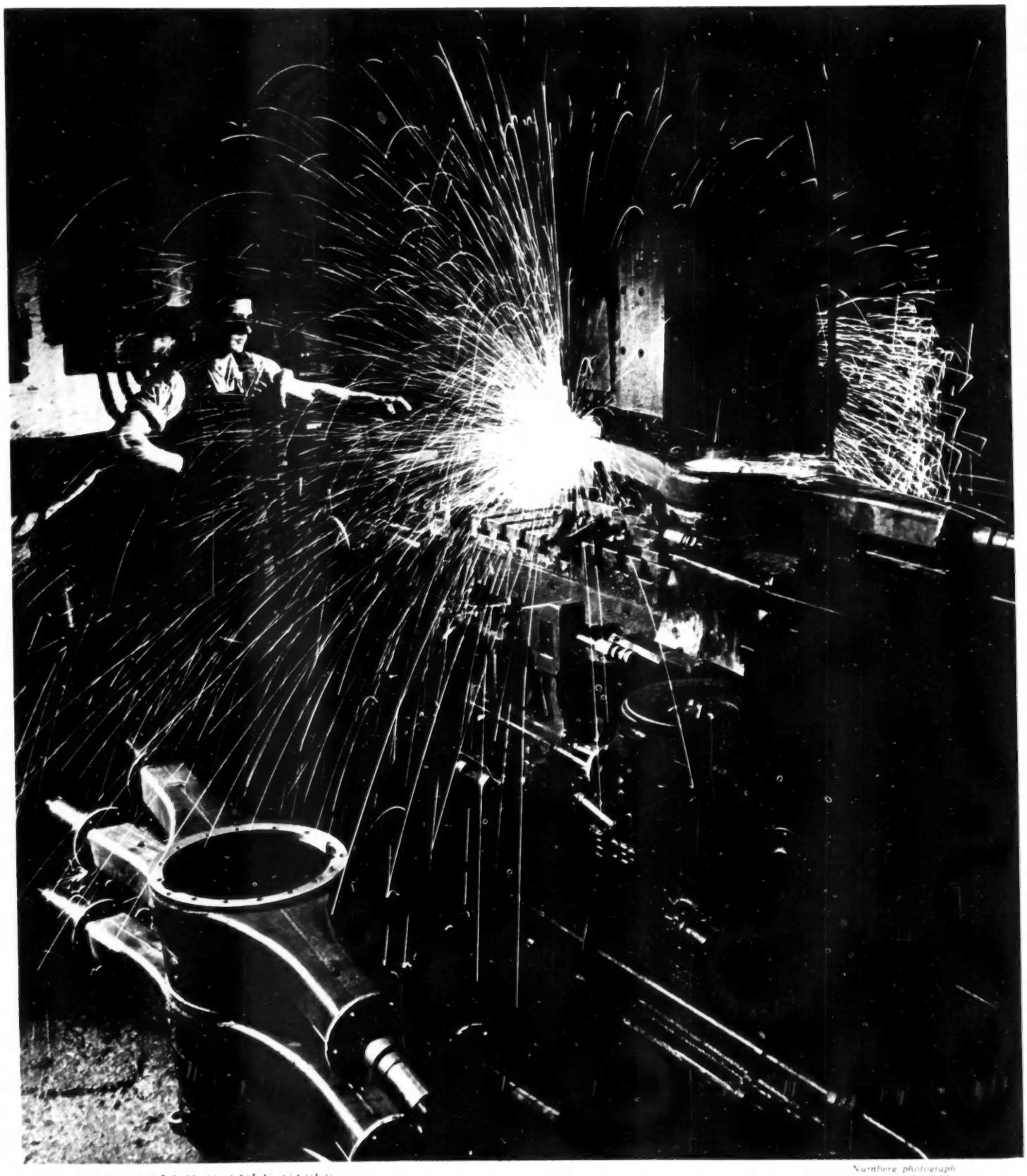

BUTT WELDING AXLE CASES

Nurnberg photograph for ENGINEERING

NOVEMBER 29, 1957 VOL. 184 PAGES 673–704

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ENGINEERS AS ORGANISERS

CRAFTS are apt to disappear as industrial change takes place. As in the classical case of the biological limitations of the dinosaur, crafts die out because they cannot adapt themselves to modern conditions. It is one of the hallmarks of a profession that it can adapt itself to changes of environment and circumstance. This is because professional men and the skills which they can deploy are based on a high average level of intelligence for the practitioner and a broad educational background. These are the two ingredients necessary for flexibility in a changing world. During the last war, it was men of high intelligence and of disciplined emotions and intellect who were able to survive in the jungles of Burma and Malaya when they were cut off from their own lines by the Japanese.

The engineer is eminently qualified as a type to survive in the modern industrial world. Two outstanding features of the modern industrial scene are the rapid pace of technological change and the increasing division of labour. So far as the rate of technological change is concerned, few are as well equipped as the engineer (along with the chemist and physicist) to adjust his ideas to new problems and new circumstances. The individual engineer may not respond to the stimuli, but taken as a whole the profession can draw comfort from the fact that the atomic age and the space age urgently need the services of engineers. The challenge of increased complication in the industrial structure is of another sort. It is a commonplace to say that we are all learning more and more about less and less. To some extent this is a danger to the engineer, especially in his younger years when his experience may be in some cases too narrowly based, but it is important to appreciate that this specialisation which leads to an increasingly complicated industrial structure is to the engineer's advantage if he adapts his ideas to it properly.

The complication of structure springs from an increased division of labour, and it is important that this division of labour should be used as a constructive weapon by the technical man as well as being recognised as a contributory factor to modern industrial organisation. Time was when the chief engineer, in so far as he can be pictured as a type say 30 years ago, was primarily an engineer but, especially if he was a works engineer, he was expected to fulfil a great many functions in purchasing, supervising, oversight of maintenance, planning and progressing as well. To-day, specialisation has taken away many of these functions from the engineer in large organisations and the trend is towards the same thing happening in smaller concerns.

There are buyers who are called purchasing officers. There are progress chasers who take on the complicated and invidious task of cajoling and bullying contractors and sub-contractors in the erection of new plant. There are production engineers and maintenance engineers. There are planning engineers. There are many other people who, if the truth were known, should not be called engineers at all but who take the title to themselves because they have a measure of responsibility in connection with the buying, producing or selling of electrical or mechanical equipment. The urge for recognition and respectability is often sought by means of a title. Many professional people, including engineers, are irritated by the misuse of descriptions of this kind, but it is a trend which cannot be directly resisted but must be used to increase industrial efficiency.

To many engineers who have acquired their experience in the classical way in industry, that is by coming up from the shop floor whether they had degree qualifications or not to start with, the shedding of functions is an unwelcome process. They have learned to keep an oversight on the key points in production, maintenance and construction of new equipment. But the very pace of technical change to-day makes it difficult for one man, with or without immediate assistance, to supervise all these aspects of engineering activity in a large organisation. He is constantly reminded that not only are there specialists available who can help him by shouldering certain aspects of his responsibilities, but that if he does not make use of them he is exposed to specialists who will take advantage of his vulnerable position. He may not like the idea of delegating certain of his functions to a professional purchasing officer, but if he does not he is open to the onslaught of a professional salesman who will study him not only as a technologist but as an intellectual and emotional problem, and adjust his approach accordingly. The engineer may not like the idea of progress chasers, but if he does not use them he is open to the easy-going attitude of contractors who know he is too preoccupied to follow every detail of production.

The engineer to-day has the opportunity of moulding the trends of development in industrial organisation in a way which will increase industrial efficiency while reinforcing the key position of his profession. He who moves with the times can use specialisation, delegation, and outside experts as means to an end. If he does so he remains the man in charge, the king-pin in a series of complicated engineering enterprises and activities.

Cover Picture. *Welding is a source of flexibility in both production and design, but calls for care in application. To-day many of the problems limiting its usefulness have been solved, and its application extended to most branches of engineering. A case in point is the electric butt welding of ends to pressed steel axle cases. The components shown are for service in heavy commercial motor vehicles.*

★ ★ ★

Plain Words

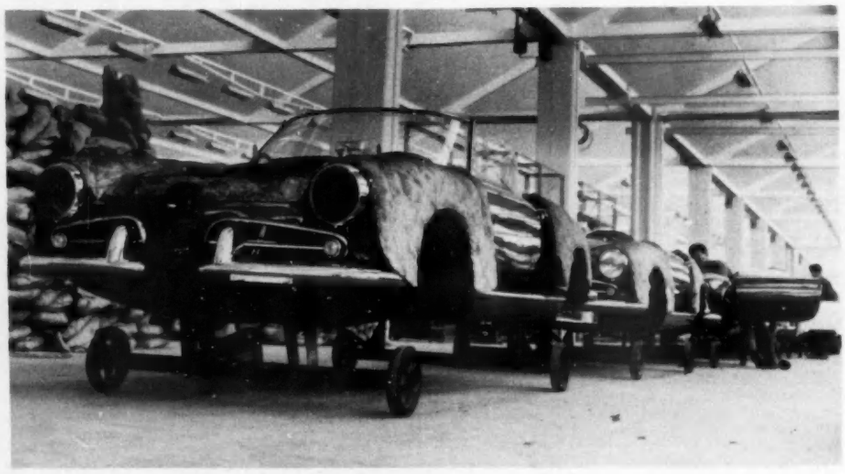
Some of the regular officers who expect to leave the Forces in the next year or so are currently reconnoitring the ground in industry. They want to gauge their chances of landing a worth-while job. Time spent on reconnaissance is seldom wasted—so runs the soldier's maxim—but anyone new to the game is likely to be rather clumsy and he may be shot at by snipers.

Employers are generally aware that the regulars are coming out on very reasonable terms. Some of them will have enough to buy a house and still have a small pension to supplement the salary from a civilian post. They will be better off, apart from lack of seniority, than most of their contemporaries who have spent the last ten or twelve years in industry. But they are coming out at an age which makes it difficult for firms to fit them into the existing promotion structure. There is always a doubt, too, whether a man who has spent his best years in the Forces has a sufficiently "commercial" outlook.

The retiring regular takes a different view, particularly if he is in one of the technical arms of the service. He knows that industry is notoriously short of engineers. He himself has probably had a full engineering education, including an apprenticeship, and he has possibly prepared himself for civilian life by devoting some of his time to study of an additional subject which would be useful in industry. His service experience has included all that a civilian acquires except the art of making a profit, but how many engineers in industry are directly responsible for making a profit? He is quite sure that, given a year or two to get the hang of things, he will be quite as capable as the men who are already settled. This reasonable confidence in himself can be too apparent at an interview; and the employer, still with the inter-war notion that regulars are Blimps at heart, not yet sure that an ex-regular is the best man for the job, is uneasy when the ex-regular himself seems to be so sure about it. If the employer, who knows industry, is not sure, how can the ex-regular, who knows so little of industry, be so sure?

There is only one person who can break this vicious circle—the retiring regular. If he will offer to start at a half, or even a third, of his service salary, on the understanding that there will be reasonable prospects within a reasonable time, he will impart confidence to the employer, he will reveal his own self-confidence in the most tactful way, and he will avoid resentment on the part of old-established employees. Industry wants him—there is no doubt about that—but the transition must be deftly handled.

Automobile Engineering



Alfa Giulietta convertibles on their trolleys, paint protected by cloth covers while equipment is installed.

CRAFTSMANSHIP IN QUANTITY

Expansion of the Italian Coachbuilding Industry

By Gordon Wilkins

Leading Italian coachbuilders, already engaged on construction of prototype bodies for many British, American, German and French car manufacturers, are expanding their production facilities in the belief that the Common Market will make it easier for foreign car makers to ship chassis to Italy to have special bodies built in small series, which may not be economical to produce at the parent factories.

Pinin Farina, now firmly established as the leader of the industry, with the able assistance of his son Sergio and his son-in-law Renzo Carli, has just moved into a fine new factory covering 210,000 sq. ft. on the outskirts of Turin. He, more than any other, has been able to reconcile design and construction of single prototypes for leading car manufacturers, with production of bodies on a commercial basis in increasing numbers. The new factory has its own press shop with presses up to 600 tons capacity, and a Keller die-cutting machine has just been installed. Thus manufacturers consulting Farina on the design of new bodies for mass production will not only have an assurance that the designs he produces can be made economically; he will even help by supplying the press tools to make them.

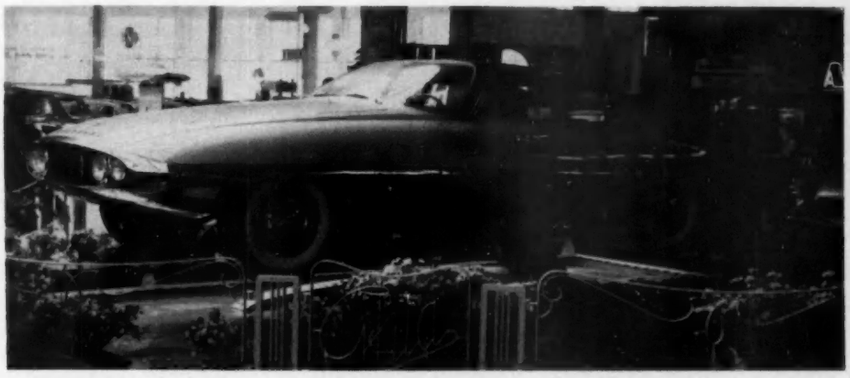
There are five assembly-trim lines, and a first-class spray-painting installation. Current production includes a series of 1,000 coupé bodies for the Lancia Appia, a new sanction for the Lancia Aurelia Gran Turismo coupé, and Spyder, some hundreds of the special short-wheelbase Alfa Giulietta convertibles, and two-door coupés for the Fiat 1200. As with other Italian coachbuilders, the finished product is usually a unit body-chassis, delivered fully trimmed and painted, with electrical equipment installed, so that the car manufacturer merely has to attach engine, transmission, suspension and steering. Usually the floor and scuttle assembly is supplied by the car manufacturer. This is the case, for example, with the Alfa Giulietta, the coupés for which are made by Bertone and the convertibles by Farina. At the Farina this job progresses from floor unit to complete body-chassis unit on a short line of four welding jigs, served by only three pairs of spot-welding tongs.

Five years ago, 500 Farina workers produced three bodies a day, now 600 are producing more than 20 a day, besides a lot of sub-contract work on brake back plates, bus doors, autocycle chassis, television, refrigerator and tractor parts, and spare parts for obsolete Fiat cars. Potential production is far higher, when the factory is fully operative.

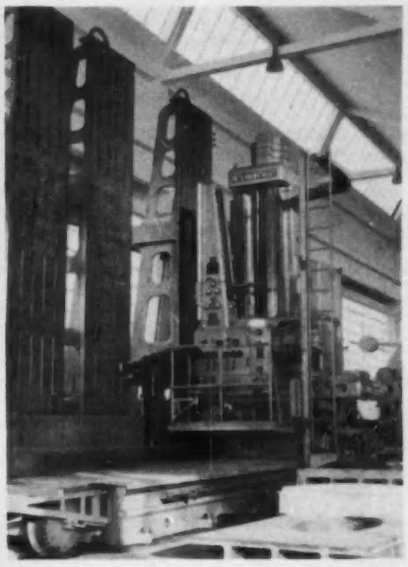
After many experiments, Farina has begun using plastic body parts. The first application is the lid of a luggage locker, which weighs 30 lb. in steel, 23 lb. in aluminium, and only 15½ lb. in resin-bonded glass fibre. It is also more rigid in plastics, and the lightness makes a favourable impression on the owner every time he opens the locker.

Various short cuts may be adopted according to the length of the production run envisaged. For short runs, the presses may be used only for

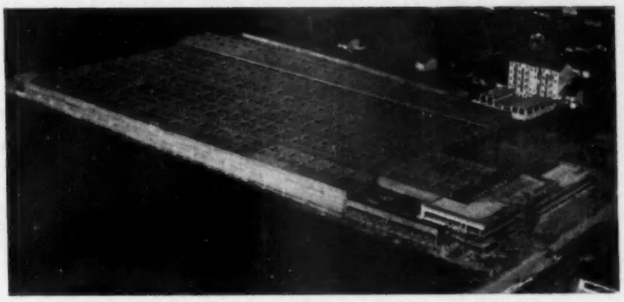
Chrysler Crown Imperial production model, lengthened and trimmed by Ghia for the U.S.A.



(Above) One of the Ghia experimental cars from which the lines of the present Chrysler range were evolved.



(Above) Heavy equipment for a coachbuilder. Farina prepares to make his own press tools—and other peoples'—at the new Turin factory, where he has installed the necessary machine tools.



(Left) Pinin Farina's new factory on the outskirts of Turin.

the main forming operations on certain panels, leaving some finishing operations to be done by hand, and techniques have been evolved to secure the most economical balance between press tools and hand labour for quantities between 250 and several thousands.

Work on prototypes is being kept at the old factory for the time being. Farina has a large measure of responsibility for the appearance of future B.M.C. models, and is producing prototypes for General Motors.

The production side of the Ghia business is also being expanded to include both cars and commercial vehicles. A new factory is being built, and the labour force of 250 will be expanded. They have built many prototypes for the Chrysler Corporation, only a few of which have been seen by the public. One, with an interesting new cantilever roof construction, was lost in the sinking of the "Andrea Doria," and others have included designs for retractable saloon tops, which stow away in the tail. An unusual production contract recently undertaken was the construction of 70 Chrysler Crown Imperial limousines, one of which is used by President Eisenhower. It is probably the world's largest car in current production, with a length of 21 ft. Chrysler ships Crown Imperial saloons, assembled but unpainted, to Turin where Ghia cuts them in half, lengthens and reinforces the chassis, rebuilds the rear doors, adds quarter lights, and reconstructs the roof. Equipment and trim is virtually to customer's choice, and full air conditioning is included. The cars are then shipped back to the United States.

Carrozzeria Touring of Milan also combine the design and construction of prototypes with series production of special bodies, and they deliver two a day of their 1900 Super Sprint coupés, trimmed and painted to the Alfa Romeo works, ready for installation of the mechanical elements. Touring recently concluded a licence agreement with the David Brown group which covers the supply of prototypes, and permission for the Tickford subsidiary to use their Superleggera body patents. This is the second English licence agreement, as Bristol car bodies are made under Superleggera patents.

Michelotti, whose designs are built in prototype form by Vignale, is also heavily engaged on behalf of the British motor industry. He was responsible for the body of the Meadows Frisky, and is at present working on a new Standard small car, and a new Triumph sports coupé.

The industry is thus entering an interesting phase of development. The artists and craftsmen are becoming industrialists, while seeking to maintain the high level of creative activity, the flexibility, and the impeccable finish on which their world-wide reputation has been founded.

(Above) Assembly lines at the new Farina factory at Turin. Left to right, Lancia Appia coupés, Lancia Aurelia Gran Turismo coupés, Alfa Giulietta convertibles.

(Right) One of a series of experimental Aston Martin bodies created by Carrozzeria Touring of Milan.

Letters to the Editor

SELLING BY FILM

SIR, It was an interesting feature of your issue of November 15 that the article on "The Uses of Films" on page 619 should have been so close to the paragraph "Selling by Film" on page 622. I do not think that the true value of films in industry will ever be appreciated until the two ideas involved in the article and the paragraph are consistently considered together.

Nearly every point of criticism raised by your contributor in "The Uses of Films" could really be answered from the paragraph, where you quote from Mr. B. Charles-Dean's thoughtful letter to *The Financial Times*. The expression "selling" is often used nowadays as a synonym for "convincing," and we talk of "selling" somebody an idea. There is quite enough truth in the conception underlying this usage for us to give a considered hearing to anybody who can talk sense about selling. Mr. Charles-Dean, as the managing director of Hartley-Ward Films, has obviously had great experience in selling; both actually selling products, and figuratively selling ideas. He is quite right, and only honest, in pointing out that film is a *method*—and it can only be used successfully if a really good film is integrated as part of a campaign.

The films which disappointed your contributor by falling below the standards set by the best seem to have done so because of lack of care in their preparation. Distracting background music and disinterested commentary are really unforgivable faults. If the sponsors and producers had seriously regarded their themes as commodities to be sold, they might have wracked their brains to better effect. Even more, they might have visualised the whole setting of their industry as a "campaign" into which their film had to be integrated. If it is necessary, in order to create this wider perspective among industrial film producers and users, it might be a good idea for them to consult more often with the men who know the true art of effective selling.

Yours faithfully,
F. J. BROWN.

Industrial and General Information,
2 Upper Cheyne-row,
London, S.W.3.
November 19, 1957.

★ ★ ★

COOLING TOWER PACKINGS

SIR, I was very interested to read Mr. E. A. Howe's reply, in your issue of November 15 (page 615), to my previous letter on page 520 of ENGINEERING for October 25, regarding cooling tower packings.

I would like, if I may, to answer Mr. Howe's letter point by point:

(1) The remarks regarding modern timber fabrication methods are of a manufacturing nature and are independent of the type of fill. Obviously, all other things being equal, there is more "manufactured surface" in an extended surface packed tower than in a splash packed tower by virtue of the fact that, in the latter, some of the air/water surface is created by droplets.

(2) Performance of cooling towers depends on the height as well as cross-section of the packing. The statement, therefore, that a smaller plan area is required for extended surface packed towers is misleading, for if one is concerned with this aspect only it is possible to operate splash-type towers with a far higher water loading than the extended-surface type and thus the plan area required is much less.

(3) The comparison of air pumping charges made by Mr. Howe is also misleading. This fact depends on whether one fits drift eliminators or not. I agree that the fan power may be less if drift eliminators are not fitted with extended surface towers but, as pointed out under item 6 of my previous letter, I firmly believe that towers of this nature should have drift eliminators to stop the considerable spray carry-over.

(4) It is pleasant to note that the manufacturers of open-trough distribution systems now make allowances for easy re-levelling after these have settled and lost alignment. Apart from the alignment question it is, however, obvious that a system working under gravity is much more likely to foul up than one working under pressure.

(5) My point regarding inspection of packings has been completely missed by Mr. Howe. Obviously, it is just as easy to inspect the bottom as the top, but what about the middle of the packing? This is the real problem.

(6) The recent report on timber deterioration, spotlighting the effect of soft rot, presents quite a problem for extended-surface packing manufacturers. The question of operational life of a packing is not one decided by the method of supporting it but whether, in fact, it will remain at all after a certain number of years. Fundamentally, because extended-surface packing is so thin its resistance to disintegration is considerably less than splash packing. The sagging of a section of the packing does not depend solely on the weight of that section. Usually film or extended-surface packing collapses sideways under the weight of the many layers. Considerable trouble with packings of this nature has been encountered in the United States.

Finally, there are two points I would like to make, namely:

(*a*) Whatever else one says, the operational efficiency of packings is best indicated by the performance guarantees given to buyers. These should be carefully assessed to note their worth.

(*b*) Mr. Howe's concluding remarks are, in fact, a plea for *discriminating operators* to specify low re-cooled water temperatures with close approaches to the wet-bulb temperature. This I must fervently and wholeheartedly oppose. In many articles that I have written on this subject I have time and time again pointed out that a cooling tower should not be considered by itself, but that the complete cooling system should be analysed as a unit. This is because if, for instance, one is able to raise the cold-water temperature by 1 deg. F., so that the approach to wet-bulb temperature is, say, 6 deg. F., and not 5 deg. F., the resulting tower could be some 30 per cent. to 40 per cent. cheaper! Thus, by slightly modifying the water-temperature requirements of the system, it is usually possible to produce a more economical scheme.

A salesman's wishes for a large cooling tower order must be subordinated to the correct technical appraisal of a client's cooling requirements.

Yours sincerely,
DEREK J. TOW.

53 Tytherton-road,
Tufnell Park,
London, N.19.
November 18, 1957.

★ ★ ★

SUBSTANCE AND SHADOW

SIR, In Plain Words of November 15 you say "the journalist is always a bystander, never a protagonist" and you go on to suggest that the substance may be more satisfying than the shadow. But who, Sir, are the players and who are the spectators? What is the arena? Where is the touchline? What is substance, and what is shadow?

Has ever a Chief of Staff in war time not requested demotion to active service on the battle-field? Was there ever an emperor of mass production who did not regret his lost opportunity in the laboratory or the surgery? How often do we hear directors of science and industry wishing that they could get back to working level if only they could afford to live on the salaries they pay their men? Sometimes, indeed, we hear of one who does.

Is it not nearer the truth to say that we are all in the arena of current events? To hold that the Press is outside the ring does less than justice to the memory of William Caxton—the man to whom, more perhaps than to any one other, we owe our modern civilisation, whether we like it or not.

Yours faithfully,
E. H. BATEMAN.

Sandyridge Cottage,
Upper Bourne,
Farnham, Surrey.
November 22, 1957.

★ ★ ★

TECHNICAL WRITING

SIR, I should like to comment on the article "Management Hampered by Bad Technical Writing," which appeared on page 137 of your issue of August 2.

In my official capacity I have charge of the research section of the chief civil engineer's department of the Southern Region of British Railways, which is responsible for making reports on a wide range of technical investigations required by the department. We have also contributed a number of papers and lectures to professional bodies and assisted in staff training courses. During this and my earlier work I have had through my hands assistants of all types, ranging from labourers, having barely the ability to write, to well-qualified engineers. My conclusions from this experience are:

(1) The ability to write well is not confined to any one stratum of society.

(2) Heredity seems to have some influence.

(3) Domestic background and environment is very important.

(4) Free essay writing at school, particularly at a very early age, such as at preparatory schools, is undoubtedly one of the most potent influences of all.

(5) Though reading of well-written matter is valuable, by far the most important factor in acquiring a good lucid style is constant practice under the direction of a supervisor who is politely, but firmly, intolerant of anything except the best exposition which the time available will permit.

(6) While the writing of concise technical reports tends to limit style, it is, nevertheless, essential to have a sound background of English grammar and vocabulary, the former being acquired at as early an age as possible and the latter by constant practice.

(7) Although eminent counsel often demonstrate a remarkable ability to pick up, at short notice, the essence of technical problems for the purpose of fighting actions in Court, I am strongly of the view that, for really effective technical writing, the writer should have technical training, adequate to enable him to have a proper appreciation of the fundamentals of what is being described. This does not mean that an Arts graduate should not write on technical matters. He may be a man of wide interests, who, had he chosen, could equally well have specialised finally in a scientific pursuit and whose versatility might fit him particularly well for that work.

(8) It seems evident that the writing of highly technical articles on specialised subjects must be reserved for those persons actively engaged in the work itself, since such publications must be authoritative. Descriptions at secondhand, in such cases, could be very dangerous.

(9) There are people who have much to offer but cannot express themselves adequately. In later life it is difficult to rectify this, but much can undoubtedly be done earlier by proper encouragement to practise both writing and

speaking. To this end, it may be necessary to permit the special allocation of time, during training, which may not have any immediate economic return.

(10) The best technical writers of my acquaintance have a wide technical background, both academically and in practice, and couple with it the urge and ability to impart their knowledge to others in the spoken and the written word.

Yours faithfully,

A. H. TOMS.

Waterloo Station,
London, S.E.1.
November 18, 1957.

★ ★ ★

SOLID PETROL

SIR, I was interested to read in "Soviet Methods with Materials," on page 616 of your issue of November 15, of a Soviet developed process for producing a form of "solidified petrol."

Towards the end of the war, a form of solidified petrol, which appeared to involve an almost exactly similar process, was shown to me by a disappointed man who had spent considerable time and money in trying to convince the British Government of its advantages. While both the details of the process and, unfortunately, the names of those behind it are now lost to me, it would be interesting to know if any of your readers have any recollection of this matter.

Yours faithfully,

P. J. FARR.

14 Great College-street,
London, S.W.1.
November 20, 1957.

★ ★ ★

VIBRATION RESISTANT FOUNDATIONS

SIR, In his letter, published on page 550 of your issue of November 1, Mr. Stanley H. Fistedis replies to my criticisms of his paper on "Vibration-Resistant Prestressed Concrete Foundations for Engines and Compressors."

The point I wished to make, and which Mr. Fistedis does not seem to accept, is that the addition of locked-up static stress to a mechanical system does not, of itself, alter the dynamic stiffness and natural frequencies of the system. This is inevitable in any linear system. If, as I mentioned, the static stress causes the material to be consolidated by closing up cracks, its dynamic stiffness may well be increased. Also, as I mentioned, if the raft bends, there will be some redistribution of soil loading underneath but this again is a secondary effect and could hardly be expected to be permanent. Neither of these effects constitutes a simple addition of static and dynamic stiffnesses which seemed to me to be the main point of the new method.

Yours faithfully,

A. J. KING.

Trafford Park,
Manchester 17.
November 21, 1957.

★ ★ ★

MORE STEEL OR BETTER CONCRETE

SIR, On page 564 of your issue of November 1, there is an article by Dr. J. R. Lawrence on "More Steel or Better Concrete for Cheaper Designs: an Economic Approach to Reinforced Concrete," which, I feel, calls for comment. While his conclusions follow from his assumptions, I would have thought that they were so startling that they would have led Dr. Lawrence to examine these assumptions.

The most important assumption is the so-called "classical theory" for the design of reinforced-concrete beams. This has long been known to give varying factors of safety for different quantities and qualities of reinforcement and concrete. In the revised British Standard Code of Practice, C.P. 114 (1957) this is recognised and the more rational "ultimate load" method is given as an alternative. (In many countries the "classical method" has been completely discarded.) The use of this method in design precludes the use of "over-reinforced" beams and gives a fairly uniform factor of safety. If cost analyses are to be made they should be made on the basis of structures of equal strength and not on the basis of obsolete theories which ignore the fundamental behaviour of reinforced concrete.

If, then, the ultimate load method is used, equations (1) and (2) of C.P.114 (1957) give, in Dr. Lawrence's notation—

$$M \leqslant \tfrac{1}{4} b d^2 f \quad . \quad . \quad . \quad (a)$$

$$M \leqslant A_s d F \left(1 - \tfrac{1}{4} \frac{A_s F}{L d f}\right) \quad . \quad (b)$$

From the first:

$$b d f \geqslant \frac{4M}{d} \text{ and } b d \geqslant \frac{4M}{d f}$$

From (b) the minimum value of A_sF, for any value of $b d f$, is given by:

$$A_s F \left(1 - \tfrac{1}{4} \frac{A_s F}{L d f}\right) = \frac{M}{d}$$

whence:

$$b d f = \frac{(A_s F)^2}{A_s F - \frac{M}{d}} \quad . \quad . \quad (c)$$

The condition (a) is satisfied if $A_sF > \frac{M}{d}$.

Let C_1 be the cost of a unit *force* in the concrete, i.e., of $b d f = 1$ and $r_1 C_1$ be the cost of unit force in the steel.

Then the total cost is given by:

$$L = r_1 C_1 (A_s F) + C_1 (b d f) \qquad \text{N.B.} \left(\frac{\delta L}{\delta r_1} > 0\right)$$

$$= r_1 C_1 (A_s F) + C_1 \frac{(A_s F)^2}{A_s F - \frac{M}{d}}$$

For minimum cost $\delta \frac{L}{\delta} (A_s F) = 0$, which gives:

$$(r_1 + 1)(A_s F)^2 - 2(r_1 + 1) A_s F \frac{M}{d} + r_1 \left(\frac{M}{d}\right)^2 = 0$$

whence:

$$A_s F = \left(1 + \sqrt{\frac{1}{1 + r_1}}\right) \frac{M}{d} \quad . \quad (d)$$

and from (c):

$$b d f = \left(\frac{2\sqrt{1 + r_1} + 2 + r_1}{\sqrt{1 + r_1}}\right) \frac{M}{d} \quad . \quad (e)$$

and the minimum cost is:

$$L = \{2 + r_1 + 2\sqrt{r_1 + 1}\} C_1 \frac{M}{d} \quad . \quad (f)$$

As this cost increases with r, it is *always* more economical to use the steel giving the *cheapest force*. The most economical concrete can then be found from (f) and the requisite dimensions from (d) and (e).

Even if the elastic theory is used it should be remembered that the majority of reinforced-concrete elements designed as rectangular sections are slabs in which the lateral dimension is fixed (as indeed it frequently is in other cases, from aesthetic and practical considerations) and the assumption that the greatest economy is provided with a maximum depth is no longer valid, since, in this case, the steel and concrete stresses will not be independent of one another but will depend on the particular value of $\frac{M}{b d^2}$. A few simple calculations show that for any given $\frac{M}{b d^2}$ the criterion of economy is practically the same as given above, but now the working stress is the maximum permissible by the elastic theory.

The application of the ultimate load theory will make Dr. Lawrence's task easier when he comes to more complex cases, since in ultimate load design, the keynote is forces and not stresses or "modular ratios," and the problem is practically that of providing the most economical force. Whether to use a smaller quantity of high-grade material or a greater quantity of lower-grade material will depend upon the ratio strength/cost of the materials; and, since the "lever arm" does not depend on the quality of the reinforcement, this is strictly true for the steel and approximately so for the concrete.

Yours faithfully,

H. TOTTENHAM.

Wellingrove,
Station-road,
Marlow,
Bucks.
November 19, 1957.

Editor's Note.—Previous letters on this subject appeared in ENGINEERING, November 22, page 644.

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"THE FULL PLASTIC MOMENT"

SIR, The letters published in ENGINEERING on the subject of the theories of bending contain a number of excellent points that might be of assistance in the further development of bending theory and research.*

The strains produced in engineering materials by applied bending moments are known to be three dimensional and those normal to the plane of bending must have a significance, so that the investigations proposed by Mr. David Ian Brindle might lead to ultimate improvement, particularly where solid or thick sections are concerned. Dr. M. R. Horne finds it necessary in defence of the "full plastic moment" to deny the possibility of even an approximate connection between measured strains and changes in stress, so that this leads one to consider whether the word "phoney" as used might not be justified. According to Newton's laws of motion the displacements of particles of the materials, as referred to by Mr. G. W. Deakin, and their directions of motion would be proportional to the changes in the local resultant forces acting on them, so that there is reason to believe that the longitudinal and transverse strains at any point of a member under the action of bending moments would be closely connected with the changes in the internal stresses.

When the flanges of long beams have been strained well beyond the yield point of the materials, the deflections could exceed the permissible limits by a number of times, and a large part of these deflections would be permanent. Engineering structures must be entirely elastic under load, so that an engineer could not reasonably take into consideration in a design the changes that might take place in the structure of the materials after the yield point has been passed. The use of better quality steels, suggested by Mr. J. R. Howgego, would evidently result in a saving of our natural resources of iron and fuel. Designs would eventually be made on a basis of maximum permissible deflections of slender members rather than on maximum working stresses. Serious overloading of a structure so designed might possibly result in cracking or in some damage of surface finishes that would be a useful indication of overloading. There would be less danger of complete collapse and on the removal of the excessive loading the members would revert to their original shape, since methods are available for safeguarding the elastic stability. This would be real progress.

Yours faithfully,

A. N. PROCTER.

528 Beechdale-road,
Western Boulevard,
Nottingham.
November 28, 1957.

* *Editor's Note.*—This subject was commenced by a letter from Mr. A. N. Procter, published in ENGINEERING, October 18, page 487; other letters have appeared in our issues of November 15, page 615; and November 22, page 645.

Companies in the News

Motor Vehicles on the Defensive

Increasingly life is becoming difficult to sustain in motor-vehicle production without, first, considerable cash reserves and capital resources, and second, a very large volume of production. This clearly emerges from the annual reports of three companies. Of them, the Rootes group are the only one to remain solely manufacturers of vehicles. Standard's output of Ferguson tractors is somewhat larger than that of cars and will steadily increase in importance as the benefits from the £4½ million investment in modern plant begin to accrue.

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The problem of Standard is essentially one of relationships with one customer. Lord Tedder's statement made quite plain that Standard have been left in an unsatisfactory position after the breakdown of the merger negotiations with Massey-Harris-Ferguson. Clearly the relationship between the two companies is most complex and it will be difficult to adjust their interests. Nonetheless, they are inextricably interconnected and it is probably more realistic to think of the merger as merely postponed until the issue is forced by circumstance. It is not at all unlikely that there will be only three volume producers in the British motor industry in 1960, two of them American-owned with associated manufacturing companies throughout the western hemisphere.

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The problems of Court Line are essentially problems of replacement, as are those of most British owners. Never has the need for fast specialised modern tonnage been more urgent. Mr. Philips commented as follows: "The recent violent fluctuations in the freight markets are by no means a new phenomenon. The tramp shipping industry has always been subject to these, and will continue to be so. That is why it is of vital importance that owners should be permitted by the Treasury to retain sufficient of their earnings in prosperous times, not only to meet the cost of maintaining and expanding their fleets, but also to provide a reserve of working capital to tide them over the bad times." The first necessity for the successful maintenance of a British fleet is a good margin of profit and a low rate of tax. The decision by Court Lines to order a ship from a French yard (the earliest delivery offered, by the end of 1961) because the delays quoted by British shipbuilders were too great, suggests that Court Line are determined not to lose ground and that they are not influenced by the fluctuations in freight rates in their replacement policy. Two ships ordered on British yards will be delivered, one at the end of 1962 and the other a year later.

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The burning-off of the rubber by various means may lead to distortion of the metal parts and has also the great objection that a thick black smoke is discharged into the atmosphere. The removal of the rubber by chemicals is limited in application and often slow, and may be "messy" in operation. Considerable interest, therefore, attaches to a de-bonding process developed by the Chemical Engineering Division of W. C. Holmes and Company, Limited, Turnbridge, Huddersfield. The method, known as the Holmes-Andre de-bonding process, is based on the principle of destructive distillation in a closed vessel in the absence of air. The process is described and illustrated in an article in the current issue of the firm's house magazine, *The Turnbridge News*, and it is upon the information contained in this article that our present account is founded.

It is stated that a de-bonding plant of this type has been in operation at a rubber factory in the London area for the past eight months and is giving every satisfaction in the reclamation of metal parts. No fumes or smoke are emitted, and, it is emphasised, the plant is quite acceptable for operation in the residential area surrounding the factory.

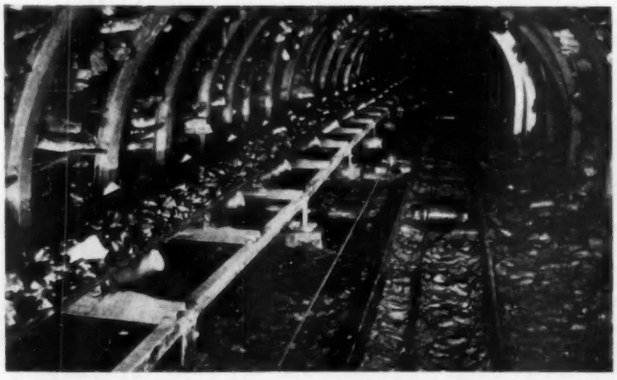
The charge of components weighing from 10 to 15 cwt. is loaded into a cylindrical container and thence into a vertical cylindrical retort, the cover of which is sealed down. The retort is heated by means of town-gas burners and the temperature is not allowed to exceed 500 deg. C. The distillation process takes approximately 7 hours and the products are gaseous, liquid and solid. The two former are separated by cooling in a condenser, while the solid product, consisting of a carbonaceous residue, remains in the container. The gaseous product, or "rubber gas," may be burned in the furnace stack or diverted into the retort furnace, thus economising in the consumption of town gas. The liquid product, a thin tar of high calorific value, may be disposed of by mixing with the works boiler fuel oil or, in this case also, may be used for heating the retort furnace.

It is stated, in conclusion, that the metal parts remaining in the container are easily cleaned by a relatively mild barrel-tumbling process.

TERYLENE-P.V.C. CONVEYOR BELT

Terylene polyester fibre has been selected for a new type of lightweight and non-inflammable belt manufactured by Rubber Improvement Limited. The National Coal Board has approved the new belt, and it is anticipated that it will be used extensively throughout the coal mining industry.

The new belt is the outcome of considerable development work by Rubber Improvement Limited, in conjunction with Imperial Chemical Industries Limited. It is composed of three plies of Terylene-reinforced fabric coated with polyvinyl chloride. Half the thickness of a six-ply cotton belt, the new belt is lighter and much more flexible whilst being just as strong and, of course, non-inflammable. The increase in flexibility reduces slipping over pulley driving surfaces and drums, which was a problem with earlier p.v.c. belts. Its light weight enables it to be used more easily for movable face-conveyors. Troughing is reported to be excellent.



A Rilflex three-ply Terylene-polyvinyl chloride lightweight non-inflammable conveyor belt in use in a Durham coal mine.

Both the low stretch and the low moisture absorption of Terylene prevent the belt varying in length with changes in humidity. The great strength of Terylene absorbs shock loads more readily so minimising damage. Its flexibility prevents the p.v.c. from being strained or cracked as the belt passes over the pulleys.

The new Terylene-p.v.c. belt is marketed by Rubber Improvement Limited, Wellingborough, Northamptonshire, under the trade name Rilflex.

MODERN PLYWOOD—MANUFACTURE AND USES

Thanks largely to the use of weather and boil-proof adhesives, modern plywood is finding increasing fields of applications in many industries. The manufacture and properties of the material are described in a number of text-books but, of late years, an increasing need has been making itself felt for concise data regarding the types of plywood available and their appropriate uses. For this reason a booklet has been prepared and issued by the Timber Development Association Limited, 21 College-hill, London, E.C.4. It contains 48 pages and is intended to provide a complete description of modern plywood for manufacturers and designers. The booklet contains many illustrations and numerous useful tables and design data. Single copies of the booklet, which is entitled *Plywood*, are obtainable without charge and post free, on application to the Director of the Association at the above address.

SANDWICH COURSE FOR STEELWORKS ENGINEERS

Under the current development plan as much as £2 million a week is being spent by the steel industry on plant which becomes increasingly complex in construction and operation. This demands more engineers of a rather special kind, and more thoroughly trained.

A steelworks engineer has to cope with an unceasing stream of problems most of which have no text-book solution. Resourcefulness and a will to make decisions are as important as sound engineering knowledge. It follows that experience in the works, where unusual occurrences are accepted as commonplace, is exceedingly important and a system of training which can combine this with the high standard of engineering science now required offers an excellent preparation for a career as a steelworks engineer. Apart from a sound background of mechanical engineering such a man needs a thorough knowledge of industrial metallurgy and such subjects as heat transfer, lubrication, soil mechanics, electro-mechanics, welded structures, and refractories. In addition the steelworks engineer should be able to appreciate the tools and application of operational research and it must also be remembered that as a member of the management team a practical knowledge of industrial relationships is essential.

The Training Committee of the British Iron and Steel Federation have decided that the shortage of engineers with such qualifications can best be tackled by the provision of a special sandwich course leading to the Diploma in Technology. Such a course would combine the essential works experience with a high standard of fundamental knowledge, and could take account of the industry's particular needs. At the same time companies outside the steel industry are supporting the course and young engineers trained in this way should have no difficulties in finding careers outside the metallurgical industries.

Some 35 chief engineers from companies of varying size have been consulted and information obtained from research associations regarding current developments. On this advice the outline proposals for the course have been formulated and a number of companies interested in the proposals have agreed to make a minimum annual number of nominations to ensure that there would be sufficient candidates to warrant the running of a separate course. Loughborough College of Technology has been invited to make arrangements for the course, and these are now well under way; recognition for the course is being sought and the first set of students will enrol at the College in January, 1958.

The industry will continue to be closely associated with the course and will co-operate with the College in providing lecturers in special subjects. Lecturers from the College will be given the opportunity of spending some time in works where they can obtain practical experience of the engineering problems involved.

This is perhaps the first time that an industry, as distinct from an individual company, has made a collective approach to educational authorities in an attempt to solve one of its technological training problems.

VEILS OFF BORON FUEL

One of the new "exotic" fuels, of the type discussed in the article on "Possible Fuels for Sputnik II" in the November 22 issue of ENGINEERING, will be on view to the public for the first time in New York at the Chemical Industries Exposition from December 2 to 26. Callery Fuels Incorporated, Pittsburgh, are to show a sample of HiCal, a high-energy fuel they are developing for the United States Navy, believed to be a compound of hydrogen, boron and carbon. A large plant for the manufacture of HiCal is now being built and will be operated by Callery for the Navy at Muskogee, Oklahoma.

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The burning-off of the rubber by various means may lead to distortion of the metal parts and has also the great objection that a thick black smoke is discharged into the atmosphere. The removal of the rubber by chemicals is limited in application and often slow, and may be "messy" in operation. Considerable interest, therefore, attaches to a de-bonding process developed by the Chemical Engineering Division of W. C. Holmes and Company, Limited, Turnbridge, Huddersfield. The method, known as the Holmes-Andre de-bonding process, is based on the principle of destructive distillation in a closed vessel in the absence of air. The process is described and illustrated in an article in the current issue of the firm's house magazine, *The Turnbridge News*, and it is upon the information contained in this article that our present account is founded.

It is stated that a de-bonding plant of this type has been in operation at a rubber factory in the London area for the past eight months and is giving every satisfaction in the reclamation of metal parts. No fumes or smoke are emitted, and, it is emphasised, the plant is quite acceptable for operation in the residential area surrounding the factory.

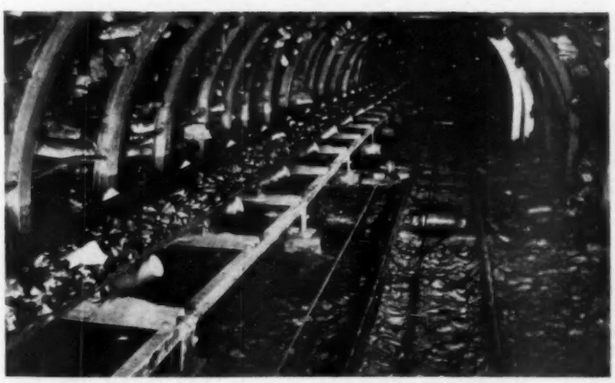
The charge of components weighing from 10 to 15 cwt. is loaded into a cylindrical container and thence into a vertical cylindrical retort, the cover of which is sealed down. The retort is heated by means of town-gas burners and the temperature is not allowed to exceed 500 deg. C. The distillation process takes approximately 7 hours and the products are gaseous, liquid and solid. The two former are separated by cooling in a condenser, while the solid product, consisting of a carbonaceous residue, remains in the container. The gaseous product, or "rubber gas," may be burned in the furnace stack or diverted into the retort furnace, thus economising in the consumption of town gas. The liquid product, a thin tar of high calorific value, may be disposed of by mixing with the works boiler fuel oil or, in this case also, may be used for heating the retort furnace.

It is stated, in conclusion, that the metal parts remaining in the container are easily cleaned by a relatively mild barrel-tumbling process.

TERYLENE-P.V.C. CONVEYOR BELT

Terylene polyester fibre has been selected for a new type of lightweight and non-inflammable belt manufactured by Rubber Improvement Limited. The National Coal Board has approved the new belt, and it is anticipated that it will be used extensively throughout the coal mining industry.

The new belt is the outcome of considerable development work by Rubber Improvement Limited, in conjunction with Imperial Chemical Industries Limited. It is composed of three plies of Terylene-reinforced fabric coated with polyvinyl chloride. Half the thickness of a six-ply cotton belt, the new belt is lighter and much more flexible whilst being just as strong and, of course, non-inflammable. The increase in flexibility reduces slipping over pulley driving surfaces and drums, which was a problem with earlier p.v.c. belts. Its light weight enables it to be used more easily for movable face-conveyors. Troughing is reported to be excellent.



A Rilflex three-ply Terylene-polyvinyl chloride lightweight non-inflammable conveyor belt in use in a Durham coal mine.

Both the low stretch and the low moisture absorption of Terylene prevent the belt varying in length with changes in humidity. The great strength of Terylene absorbs shock loads more readily so minimising damage. Its flexibility prevents the p.v.c. from being strained or cracked as the belt passes over the pulleys.

The new Terylene-p.v.c. belt is marketed by Rubber Improvement Limited, Wellingborough, Northamptonshire, under the trade name Rilflex.

MODERN PLYWOOD—MANUFACTURE AND USES

Thanks largely to the use of weather and boil-proof adhesives, modern plywood is finding increasing fields of applications in many industries. The manufacture and properties of the material are described in a number of text-books but, of late years, an increasing need has been making itself felt for concise data regarding the types of plywood available and their appropriate uses. For this reason a booklet has been prepared and issued by the Timber Development Association Limited, 21 College-hill, London, E.C.4. It contains 48 pages and is intended to provide a complete description of modern plywood for manufacturers and designers. The booklet contains many illustrations and numerous useful tables and design data. Single copies of the booklet, which is entitled *Plywood*, are obtainable without charge and post free, on application to the Director of the Association at the above address.

SANDWICH COURSE FOR STEELWORKS ENGINEERS

Under the current development plan as much as £2 million a week is being spent by the steel industry on plant which becomes increasingly complex in construction and operation. This demands more engineers of a rather special kind, and more thoroughly trained.

A steelworks engineer has to cope with an unceasing stream of problems most of which have no text-book solution. Resourcefulness and a will to make decisions are as important as sound engineering knowledge. It follows that experience in the works, where unusual occurrences are accepted as commonplace, is exceedingly important and a system of training which can combine this with the high standard of engineering science now required offers an excellent preparation for a career as a steelworks engineer. Apart from a sound background of mechanical engineering such a man needs a thorough knowledge of industrial metallurgy and such subjects as heat transfer, lubrication, soil mechanics, electro-mechanics, welded structures, and refractories. In addition the steelworks engineer should be able to appreciate the tools and application of operational research and it must also be remembered that as a member of the management team a practical knowledge of industrial relationships is essential.

The Training Committee of the British Iron and Steel Federation have decided that the shortage of engineers with such qualifications can best be tackled by the provision of a special sandwich course leading to the Diploma in Technology. Such a course would combine the essential works experience with a high standard of fundamental knowledge, and could take account of the industry's particular needs. At the same time companies outside the steel industry are supporting the course and young engineers trained in this way should have no difficulties in finding careers outside the metallurgical industries.

Some 35 chief engineers from companies of varying size have been consulted and information obtained from research associations regarding current developments. On this advice the outline proposals for the course have been formulated and a number of companies interested in the proposals have agreed to make a minimum annual number of nominations to ensure that there would be sufficient candidates to warrant the running of a separate course. Loughborough College of Technology has been invited to make arrangements for the course, and these are now well under way; recognition for the course is being sought and the first set of students will enrol at the College in January, 1958.

The industry will continue to be closely associated with the course and will co-operate with the College in providing lecturers in special subjects. Lecturers from the College will be given the opportunity of spending some time in works where they can obtain practical experience of the engineering problems involved.

This is perhaps the first time that an industry, as distinct from an individual company, has made a collective approach to educational authorities in an attempt to solve one of its technological training problems.

VEILS OFF BORON FUEL

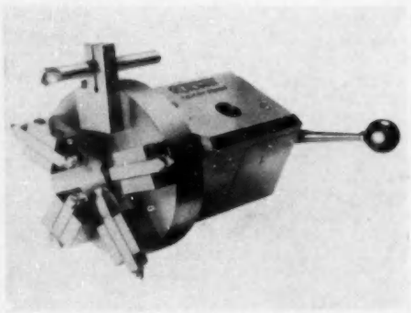
One of the new "exotic" fuels, of the type discussed in the article on "Possible Fuels for Sputnik II" in the November 22 issue of ENGINEERING, will be on view to the public for the first time in New York at the Chemical Industries Exposition from December 2 to 26. Callery Fuels Incorporated, Pittsburgh, are to show a sample of HiCal, a high-energy fuel they are developing for the United States Navy, believed to be a compound of hydrogen, boron and carbon. A large plant for the manufacture of HiCal is now being built and will be operated by Callery for the Navy at Muskogee, Oklahoma.

Plant and Equipment

TURRET ATTACHMENT FOR CENTRE LATHES

Slide Mounting

A new turret tool holder known as the "HSR Automat," is available for mounting on the compound slide of a centre lathe. Made in six sizes—from 2·835 in. to 7·874 in. turret diameter—by Heinrich Schmid, Rapperswil, Switzerland, the tool head is distributed in this country by the Insley Industrial Supply Company, Limited, 21/22 Poland-street, London, W.1.



The "HSR Automat" turret tool holder is designed for mounting on the compound slide of an ordinary centre lathe. It is made in six sizes ranging from 2·835 in. to 7·874 in. in diameter.

The turret is carried on a horizontal spindle, and is indexed and locked by a single hand lever. It accommodates square tools or tool-holders, and has rapid screw adjustment for setting the tools to centre height. Being mounted on the compound slide of the lathe, and so receiving all its motions, the tool head is equally suitable for turning, boring, facing or undercutting, in exactly the same way as an ordinary post-mounted tool.

HYDRAULIC LIFT GEAR FOR SEMI-TRAILERS

A version of the Tugmaster tractor manufactured by Douglas Equipment Limited, Kingsditch-lane, Dukesborough-road, Cheltenham, has recently been put on the market, incorporating a hydraulic lift gear for coupling a semi-trailer. The model DC3S on which this equipment is fitted has been designed for overseas operation, handling gross trailer weights of 60 tons. The basic chassis is of a standard model as also are the transfer box and many other components. Petrol and Diesel engines are available with powers of 100 or 150 h.p. It has a speed range of 1 to 15 m.p.h.

The hydraulically operated "fifth wheel" is constructed from two hydraulic rams produced from high-grade steel, both of which are carried in a heavy duty subframe mounted on trunnions to give universal action, while the top end has mounted two heavy duty balls bearing in spherical housings. The spherical housings are carried in a heavy-duty cross member located in the two lifting beams which are in turn carried on two hinged brackets, fixed on the chassis frame immediately behind the cab. At the rearmost end of these lifting beams a standard S.A.E. fifth wheel is mounted. The wheel may be raised from 44 in. minimum height to 59 in. maximum. The universal mountings prevent torsional loads on the rams.

The hydraulic lift gear for connecting semi-trailers to the Tugmaster tractor has a lift of 15 in. and a load capacity of 30 tons.

BRIGHTER CINEMA PROJECTION

A step towards the automatic cinema is taken in the new 450-X projector of the British Thomson-Houston Company, Limited, Rugby. It uses a Mazda XE/D xenon lamp instead of a carbon arc. The latter presents problems of ventilation and requires a trained operator to cope with the changing of carbons and the consequent arc adjustments. The xenon lamp needs no attention after switching on. It also has no warming up period.

The Mazda lamp is used horizontally. This is an advantage as the most brilliant part of the arc is rectangular and, when the tube is horizontal, corresponds to the shape of the screen. Thus the maximum light is available for projection. Inadequate screen illumination has been the limitation preventing the use of 16 mm. sound-film projectors in any but the smaller halls. Previous projectors for such film have used tungsten lamps. The xenon lamp gives about four times the light output of a modern 750 watt tungsten filament lamp. An experimental 35 mm. projector using a xenon lamp is at present being used in a Brixton cinema.

A two-electrode xenon lamp is produced in Germany, but it has to be used vertically. The Mazda lamp has an additional electrode that assists starting and stabilises the arc in the horizontal position. Fig. 1 shows the lamp. A gas-filled envelope of fused silica encloses the three electrodes—anode, cathode, and igniter. Of almost optical quality, the silica is strong enough to need no protective casing. The light it emits extends over the whole visible spectrum from the ultra-violet to the infra-red. The colour temperature of the light is about 5,600 deg. K.

The lamphouse contains a lamp mounting that can be adjusted for the initial alignment of the arc. It also contains the high-voltage supply unit for arc ignition, and a condenser-lens and rear-mirror system that puts the light in the projector. A small blower cools the lens system and ventilates the lamphouse. Fig. 2 shows the manner in which the lamp is mounted. Big doors allow easy access, but interlocks prevent opening while the lamp is alight.

The projector-lamphouse assembly is mounted at a convenient operating height on top of the power supply cabinet. Contained in the latter is a single-phase transformer and germanium rectifier with a voltage-doubling circuit and smoothing. The unit gives a direct current output of 100 amps. at 20 to 30 volts. A 7 in. diameter axial-flow fan cools the rectifier. Under normal conditions, with the projector running and using a 2 in. $f/1{\cdot}5$ projection lens, a total screen illumination of 1,000 lumens is obtained. With a terminal voltage of 28-30 volts the lamp is nominally rated at 2 kW.

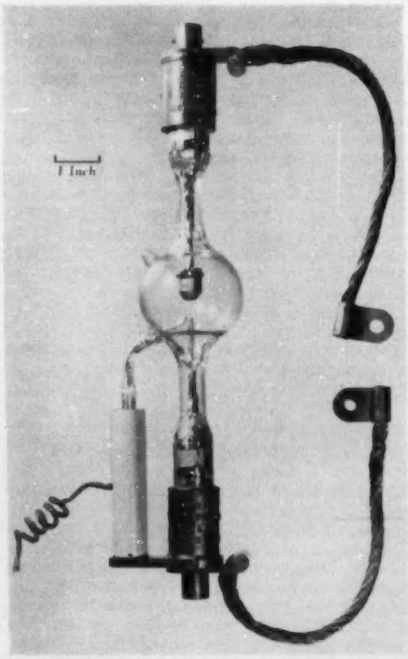


Fig. 1 The 2 kW xenon lamp gives the brilliance of arc lighting to 16 mm. films. A third electrode, on the left, stabilises the arc.

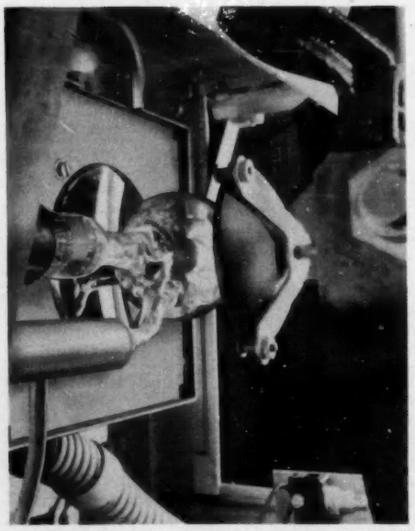


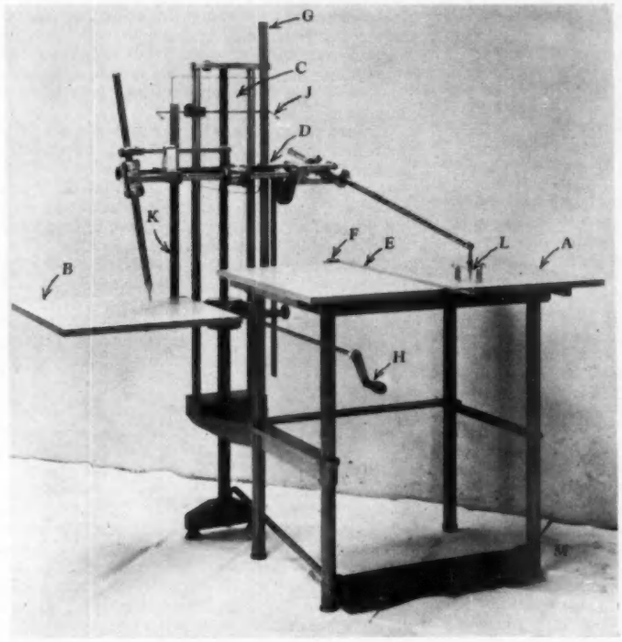
Fig. 2 Inside the lamphouse the xenon lamp is mounted horizontally. The hose at the bottom of the picture directs the cooling air.

DRAWING TRUE PERSPECTIVES

Three dimensional drawings, often revealing cut-away or "exploded" views, are being increasingly used to illustrate maintenance handbooks and other technical publications; and perspective illustrations are a valuable asset to the architect and consulting structural engineer in putting their ideas across to the client. The construction of true perspective drawings is, however, a time-consuming and highly skilled task, and the demand for technical illustrators who can carry out such work to-day exceeds the supply.

To overcome this difficulty, there has been developed the Autoperspect apparatus, a high-precision drawing instrument which makes it possible to produce accurate drawings in true perspective, with a choice of angle of view and scale of reproduction, using only a plan and elevation drawing. A draughtsman of only moderate ability can soon master the technique.

The Autoperspect is shown in the accompanying illustration, from which it may be seen that the apparatus consists of a table A, at the rear of which is a vertically adjustable frame supporting a small table B which represents the picture plane, a vertical table C, and a linkage D, which connects the scriber arm with the pencil arm and transmits a congruent movement between them. In operation, a plan of the object to be drawn is placed on the object table A at a predetermined distance from the theoretical eye-point measured on the scale E and at a selected angle which can be measured on a graduated pivot F. An elevation drawing is placed on the vertical table C and is indexed for height on scale G by operating the elevation control handle H. When this height is fixed the index line J is set to an appropriate plane on the elevation drawing. To set the scale of reproduction the picture table B can be adjusted for height, reading this on scale K. The tracer point L is then placed on the plan drawing and the pedal M depressed, thereby lowering the pencil arm on to the picture table B. On tracing the plan, a true perspective drawing is reproduced for the selected plane on the elevation, and by operating the handle H to bring another elevation plane under the index line J the operation is repeated for that plane. When all planes have been dealt with in this manner a perspective will have been completed on the picture table.



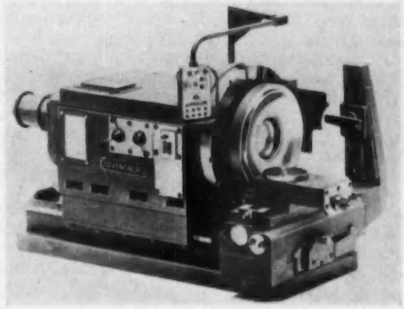
True perspectives can be quickly drawn by a semi-skilled draughtsman using the Autoperspect precision drawing apparatus.

To ensure the continued smooth operation of the instrument, linear roller bearings are employed on all sliding motions of the linkage, and all moving parts are in precision-ground stainless steel.

Up to the present time the apparatus, which, the manufacturers claim, can cut down the time taken over perspective drawings to one-third to one-seventh, has been available only in Sweden. It is now being manufactured and marketed in the United Kingdom by Autoperspective Limited, 5 Victoria-street, London, S.W.1, from whom all details can be obtained and demonstrations of its versatility arranged.

HYDRAULIC FACE COPYING LATHE

Work up to 55 in. maximum diameter can be machined to any desired contour by means of a tracer template, and electronic-hydraulic copying system on the new copying lathe made by Maschinenfabrik Ravensburg, AG., Ravensburg, Germany. The machine, for which the British agents are the Mortimer Engineering Company, 204/206 Acton-lane, Harlesden, London, N.W.10, has a sliding headstock which enables it to machine workpieces of widths varying between approximately 4 in. and 31½ in. Hydraulic traverse and clamping are provided for the headstock, which moves on two V-ways.



The Ravensburg face copying lathe can be used under template control, with a dog-controlled sequence or manually. All the feeds are hydraulic.

The headstock has a built-in motor drive of 20, 27 or 33 h.p. as required, operating through a P.I.V. gear which gives stepless variation within the ratio of 4 to 1 to each of 12 gearbox speeds. This arrangement provides a range of faceplate speeds from 4 to 180 r.p.m. Sliding feed and infeed are both hydraulic, and have speeds which are infinitely variable from 0·04 in. to 7 in. per minute.

The copying equipment is of the manufacturers' well-known "Unicop" type, with electronic-hydraulic control. It works normally by means of a tracer template, which can be seen in the accompanying illustration, but the machine can also be used without the tracer and template, using the hydraulic feeds for turning under manual control. As an alternative to template copying it is possible to set the machine to operate on suitable work by means of dogs which will control the hydraulic feeds according to a set pattern.

VOLTMETER FOR 1,000 MC/S.

An improvement to their vacuum tube voltmeter, type TF 1041, has been announced by Marconi Instruments Limited, St. Albans, Hertfordshire. The TF1041 has a frequency range extending from 20 c/s to 1,000 Mc/s. The input capacitance is 1·5 $\mu\mu$F; the input resistance is 0·5 Megohm at 10 Mc/s and 150 kilohm at 100 Mc/s. For measuring alternating potentials a probe unit is available that makes point contact with the source under test. In the unit a disc-seal diode rectifier is housed that has a resonant frequency of 3,000 Mc/s. The probe weighs 1½ oz.

Alternating potentials between 0·05 and 300 volts can be measured. Unidirectional potentials can be measured up to 1,000 volts at an input impedance of 40 megohm balanced, or 20 megohm unbalanced. The direct current section of the voltmeter is essentially a two-stage impedance converter. Each stage embodies two cathode followers and there is heavy degeneration between the input points and the moving coil meter across the output.

PUNCHED TAPE TYPEWRITER

An electric typewriter equipped with a tape punch unit is being produced in America. When used as an ordinary typewriter it also translates the typescript into punched tape. The tape punch fitted will perforate 5, 6, 7, or 8 channel paper tape in accordance with specific code requirements. All the characters on a typewriter can be coded.

The punched tape can be used in data processing systems or can be fed through a read unit attached to the typewriter. In the latter case the machine automatically types out the information at 120 words a minute.

The machine is called the electronic punch paper tape typewriter. It is produced in America by Remington Rand. The electric typewriter includes a base 44-key keyboard and is equipped with 13, 15, 20, or 27 in. carriages. A tape punch and tape read unit is plugged in as required. Inquiries concerning the electronic punch paper tape typewriter should be addressed to Remington Rand Limited, 1-19 New Oxford-street, London, W.C.1.

HEAT PUMP FOR SHOPS

For all applications where the atmosphere is required to be kept cool and a supply of hot water is also needed, the heat-pump type of refrigerator is suitable. A unit for industrial uses, in kitchens, food stores, dairies and the like, is now being marketed by Heat Pump and Refrigeration Limited, 34 Napier-road, Bromley, Kent. The unit is designed to provide hot water at 140 deg. F. in quantities from 150 to 280 gallons per day, according to the size of the compressor unit. There are three sizes of this, driven by ½ h.p., ¾ h.p. or 1 h.p. motors. The cooling capacity of the 1 h.p. model is 9,500 B.Th.U. per hour (maximum rating), and the air circulation that it provides is 1,000 cub. ft. per minute. The air throw is 15 ft. maximum. The power input is 1·2 to 1·5 kilowatts and the refrigerant is Freon 12. The unit requires 4 sq. ft. floor space, but if this is not available, it can be split into separate sections and mounted at a higher level. Alternatively, the hot water portion can be sited remote from the cooler unit. Control is by individual thermostat, and air circulation can be adjusted in any direction.

Management

Weekly Survey

Transport and Automation

One would expect that automation, being concerned pre-eminently with the movement of men, machines and materials, would have particular appeal to transport. This is particularly so these days since communications of all kinds must cope not only with a large number of variables, which are the very essence of communication, but also temporary limiting physical conditions (such as congestion on the roads) and a rapid rate of technical change (such as the combination in the air of greater traffic density and high-speed aircraft). Yet, according to Sir Walter Puckey in his recent address to the Institute of Transport, the relatively few computers ordered by transport groups are mostly for payroll tasks.

Pointing out that one vital aspect of good management and the optimum use of technical knowledge and equipment is continuous movement, Sir Walter said that this involved control of three kinds—quantity control, time control and quality control. Much time was being given, he said, to better methods of quantity control but only 10 per cent. of all digital computer applications in Britain are in this field. Emphasising the importance of efficiency in time control, he referred to the assertion which has often been made, and which few will dispute, that a much greater increase in productivity has already been obtained from increasing the efficiency of flow and the better planning and servicing of machines than by sheer labour effort. On quality control, he emphasised the importance of increasing the use of measurement-on-the-move. In the case of transport, Sir Walter drew attention to the vast progress which has been made of recent years in the speed and control of aircraft in contrast with the large scope which still remains for organising passengers and freight between large population areas and air terminals. He completed his remarks by drawing attention to the need for basic thinking on transport, work which could be greatly facilitated if computers were used to handle the large number of variables to be considered. He put out the thought, for example, that in a country with as high a population density as the United Kingdom the basic objective should be to achieve the smallest volume of transport per unit of national product. Sir Walter did not say so, but if this is a reasonable objective (and the well-known axiom that handling adds cost without value to a product gives it a great deal of attraction) the solution which would be achieved after a massive series of calculations would not necessarily be the one which we are groping towards at the present time, namely, bigger and better roads.

* * *

I.C.I. Back Unified Threads

Prominent among the industries which have adopted, or are in process of adopting, Unified screw threads are the aircraft, motor-car, and oil industries. As the original discussions were commenced largely as a result of war-time Services pressure, many engineering firms carrying out a high proportion of Government contracts have changed over to the new threads. It appears, however, that various heavy industries have not shown much enthusiasm for the Unified threads, and that the railway and coal industries have made little or no move in this direction. It is also understood that the electrical industry is not particularly favourable and that the shipbuilding and marine-engineering industries have little desire for a change so far.

Bearing these facts in mind, it is interesting to learn that those manufacturing divisions of Imperial Chemical Industries Limited, which have not already done so, are to adopt, as standard, the Unified screw threads and the Unified bolts and nuts, in place of the present Whitworth standards. The firm will require all equipment which formerly would have been provided with Whitworth, B.S.W. or B.S.F. threads to have Unified (UNC, UNF or UNS) threads. Some other kinds of threads used by the company, however, will remain standard, including B.A. threads, pipe threads and other special-purpose types such as the Acme, square and buttress threads.

It is expected that the change will take several years to be completed, as it will progress at a rate governed by equipment changes. It appears, however, that the Billingham Division of the company, which decided to make the change in January, 1955, is already well advanced with its programme of conversion.

* * *

Jolt for Uganda

The Calico Printers Association Limited and the Bleachers Association Limited announced last week that they are to withdraw their interest in the Uganda textile industry. This took the form of a 58½ per cent. interest held by the two companies in Nyanza Textiles Limited, in which the other partner was the Uganda Development Corporation. The factory is situated at Jinja, a few miles south of the Owen Falls hydro-electric scheme on the Victoria Nile. Two main reasons were given for this withdrawal; the high African labour turnover and increasing competition from imported Indian cloth. The importance C.P.A. and Bleachers attach to these factors can be gauged from the fact that they are prepared to accept £783,000 out of their original investment of £1·1 million in Nyanza—a 25 per cent. loss.

This news raises important questions for the future of the extensive hydro-electric scheme initiated by the Uganda Electricity Board. £23 million has been spent by the Board on Owen Falls and its distribution system. This sum was felt to be justified owing to the interest shown in industrial development in Uganda, which has no coal or oil. In consequence, the Electricity Board felt able to predict in 1948 that demand for electricity would reach 150,000 kW per annum by 1962, compared with under 2,000 kW in 1948. Nyanza Textiles is one of the Board's biggest customers, and was planning to expand its annual production of cloth to 9 million square yards, worth £1 million. Any severe loss of revenue from Nyanza, which is the biggest manufacturing concern in Uganda, must have immediate repercussions.

Meanwhile, there is no sign that other overseas interests share C.P.A.'s pessimism. Frobishers Limited are now the principal overseas company operating in Uganda. Together with the Uganda Development Corporation they form the Tororo Exploration Company, with a capital of £1·3 million, which is now working phosphate and niobium deposits near Tororo. Frobishers also have interest in the Kilembe copper and cobalt mines, in which they shared a capital outlay of £7 million with the Uganda Development Corporation and the Colonial Development Corporation. The Kilembe area is said to have reserves of 13½ million tons of ore. Work is also under way at Jinja on a smelter to process the ore mined at Kimbele. If there are any setbacks from Nyanza they can probably be offset by expansion elsewhere in due course, but the old lesson, so often neglected in the colonies, has still to be learned here, namely, the unwisdom of starting new enterprises without a thorough study of the market.

* * *

Italy's Nationalised Engineers

Nationalisation in Italy came about in a haphazard way. A number of large firms were heavily in debt to the banks, which found themselves in the position of providing the short-term funds for industry without having any control over policy. In 1933 Mussolini set up the Institute for the Reconstruction of Industry (I.R.I.) as a holding company for all the hard pressed firms. The qualification for nationalisation was therefore the unusual one of insolvency. Since that time I.R.I. has been re-organised into five main groups covering iron and steel, shipping, electricity supply, telephones and engineering.

The engineering group Finmeccanica consists of 35 separate firms employing over 72,000 workers. The group's biggest interests are in the shipbuilding industry, of which it controls 75 per cent. of production capacity. The rest of its activities range over the whole field of engineering, including electrical machinery, optics, precision instruments, rolling stock, tractors, electrical engineering and heat-generating motors. Several famous names appear on the list of I.R.I. firms. Ansaldo in shipbuilding, Alfa-Romeo in motor cars are perhaps the best known in this country. The capital of the Finmeccanica group is controlled almost entirely by I.R.I. which acts as a holding company. The group is managed by a board of directors representing I.R.I., the Italian Government and the Finmeccanica companies. The factories in the group are visited by inspectors from both I.R.I. and group headquarters. Since Finmeccanica was set up in 1947 there has been a big increase in export orders, especially in such things as railway rolling stock for the Far East.

Nevertheless, Italians have never got over the fact that I.R.I. was originally in Mussolini's words "a hospital for sick industries." They feel, with a great deal of truth, that the firms concerned have had a very long period of convalescence during which they have enjoyed the advantages of state aid on a big scale. The question was brought down to brass tacks by the Italian engineer who said "If Finmeccanica and I.R.I. were any good they would have produced a cheaper car than Fiat by now." Until this happens, Italy's nationalised engineers will be regarded with suspicion.

* * *

Lower Returns on Capital

A clear trend of a reduced rate of increase in trading profits and of an actual decrease in the earnings of equity shareholders emerges from an analysis of nearly 3,000 accounts of companies whose financial year ends during the first ten months of 1957. Most of these relate to trading in 1956 and early this year, a period during which the Government's policy of dearer money and credit restrictions was becoming effective. Clearly, a lower rate of return on capital must now be expected, as might be the case in the closing stages of a boom. The *Financial Times*' analysis reveals that the average annual increase in profits, which amounted to 10½ per cent. for the same companies the previous year, had been reduced to 4½ per cent., while earnings for equity shareholders actually fell by nearly 2 per cent. During the same period the index of wage rates rose by 7 per cent.

Quite deliberately, the Government directed the credit squeeze against industries making consumer durable goods. Trading profits of both motor companies and household goods manufacturers were 12 per cent. down on the year. The importance of these industries as a source of business for the remainder of the engineering industries was reflected in the very slight increase in trading profits averaged by this sector and in a sizeable restriction in earnings. Towards the spring of this year recovery set in, and considerably higher profits were earned. The small range of 198 companies whose reports were received during October show trading profits of £102·5 million, nearly 17 per cent. higher than the preceding year and earnings on ordinary shares of £401 million, or 6·2 per cent. higher. The performance of the industrial companies among them was less good but good enough to indicate an upturn.

EXHIBITIONS AND CONFERENCES

This list, in chronological order, appears in the last issue of each month. Events noticed for the first time and alterations of dates, places, etc., are indicated by an asterisk (*). For details of events not included below, reference should be made to ENGINEERING, *September 27, page 398, and October 25, page 527. Organisers are invited to send particulars of coming events to the Editor.*

ASTM Meetings on Concrete and Concrete Aggregates.—Mon., Dec. 2, to Fri., Dec. 6, at Fortin de las Flores, Mexico. Organised by the American Society for Testing Materials, 1916 Race-street, Philadelphia 3, Pa., U.S.A.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., Dec. 2, to Fri., Dec. 6, at Earls Court, London, S.W.5. Apply to the exhibition manager, Smithfield Show Joint Committee, 148 Piccadilly, W.1. Tel. GROsvenor 4040.

Chemical Industries Exposition, 26th.—Mon., Dec. 2, to Fri., Dec. 6, at the New York Coliseum, New York. Organised by the International Exposition Co., 480 Lexington-avenue, New York 17, U.S.A.

Combustion of Solid and Powdered Fuels, Conference.—Wed., Dec. 4, to Sat., Dec. 7, at 7 Rue La Pérouse, Paris. Organised by the Institut Français des Combustibles et de l'Energie, 3 Rue Henri Heine, Paris 16e.

Hong Kong Products, 15th Exhibition.—Wed., Dec. 4, to Thurs., Jan. 2, 1958, at Tsim Sha Tsui, Kowloon, Hong Kong. Organised by the Chinese Manufacturers' Union, 64-65 Connaught-road Central, Hong Kong.

***Cybernetics, International Association of.**—Fri., and Sat., Dec. 13 and 14, at Namur. Conference on "Economic and Social Implications of Automation." Offices of the Association: 13 Rue Basse-Marcelle, Namur, Belgium.

Solid State Physics, Second Conference.—Thurs. and Fri., Dec. 19 and 20, at Imperial College, London, S.W.7. Theme: "Band Theory of Metals and Experimental Investigations into the Structure of the Fermi Surface." Apply to the secretary, the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.7. Tel. KENsington 0048.

National Boat Show.—Wed., Jan 1, to Sat., Jan. 11, 1958, at Olympia, London, W.14. Organised by the Ship and Boat Builders' National Federation. 205 Regent-street, London, W.1. Tel. REGent 1108.

AIRCRAFT PRODUCTION PROBLEMS

Problems of Aircraft Production, Sixth Annual Conference.—Thurs. and Fri., Jan 2 and 3, 1958, at The University, Southampton. Theme: "United States and United Kingdom Practice." Organised by the Southampton Section of the Institution of Production Engineers, 10 Chesterfield-street, London, S.W.1. Tel. GROsvenor 5254.

Indian Science Congress Association, 45th Meeting.—Thurs., Jan 2, to Wed., Jan. 8, 1958, in Calcutta. Organised by the Association, 1 Park-street, Calcutta 16, India.

International Book Exhibition.—Tues., Jan 14, to Sun., Jan. 19, 1958, in Tokyo. *Representative:* Mr. A. P. Wales, 36-38 Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

Motor Boat Show, National.—Sat., Jan. 18, to Sun., Jan. 26, 1958, at the Coliseum, New York. Organised by the National Association of Engine and Boat Manufacturers, 420 Lexington-avenue, New York City 17.

Convention and Exposition of the National Association of Home Builders, 14th Annual.—Sun., Jan. 19, to Thurs., Jan. 23, 1958, at the Coliseum, Chicago. Offices of the Convention: 140 South Dearborn-street, Chicago 3, Ill., U.S.A.

Synoptic Meteorology, World Meteorological Organization's Commission for.—Tues., Jan. 21, to Fri., Feb. 14, 1958, at New Delhi, India. Second session, organised by the W.M.O. Secretariat, Avenue de la Paix, Campaigne Rigot, Geneva, Switzerland.

Eastern Canada Hardware Show.—Mon., Jan. 27, to Thurs., Jan. 30, 1958, at the Show Mart, Montreal. Organised by Eastern Canada Exhibitions, Inc., 1600 Berri-street, Montreal, Canada.

Canada Farm and Industrial Equipment Trade Show.—Wed., Jan. 29, to Sat., Feb. 1, 1958, in the Coliseum, Exhibition Park, Toronto. Organised by Canada Farm and Industrial Equipment Trade Show, Ltd., Wellesley-street East, Toronto 5, Ontario, Canada.

Progress and Trends in Chemical and Petroleum Instrumentation, National Conference.—Mon., and Tues., Feb. 3 and 4, 1958, at Wilmington, Delaware, U.S.A. Organised by the Instrument Society of America, 313 Sixth-avenue, Pittsburg 22, Pa., U.S.A.

Canadian Institute of Surveying and Photogrammetry, Annual Meeting.—Wed., Feb. 5, to Fri., Feb. 7, 1958, at Ottawa. Organised by the Institute, P.O. Box 57, Westboro, Ontario, Canada.

Developments in Foundry Technology, Symposium.—Wed., Feb. 5, to Sat., Feb. 8, 1958, at Jamshedpur. Organised by the National Metallurgical Laboratory, Council of Scientific and Industrial Research, Jamshedpur 7, India.

Non-Destructive Testing of Materials, Course on.—Sun., Feb. 9, to Sat., Feb. 22, 1958, in London and the provinces. Fee £42. Organised by the British Council, 65 Davies-street, London, W.1. (Tel. GROsvenor 8011), for people from overseas.

***Fuel Efficiency in the Metal Industries, All-Day Discussion.**—Wed., Feb. 26, 1958, at the College of Technology, Gosta Green, Birmingham. Organised by the Institute of Metals, 17 Belgrave-square, London, S.W.1. Tel. BELgravia 3291.

***Ideal Home Exhibition.**—Golden Jubilee Exhibition, Tues., Mar. 4, to Sat., Mar. 29, 1958, at Olympia, London, W.14. Organised for the "Daily Mail" by Associated Newspapers, Ltd., 161-163 Queen Victoria-street, London, E.C.4. Tel. FLEet 6000.

Nuclear Congress.—Sun., Mar. 16, to Fri., Mar. 21, 1958, at Chicago, Ill., U.S.A. Organised by the American Institute of Chemical Engineers, 25 West 45th-street, New York 26. Apply to the Engineers' Joint Council, 29 West 39th-street, New York 18. See also ENGINEERING, August 26, page 219.

Physical Society's Exhibition of Scientific Instruments and Apparatus.—Mon., Mar. 24, to Thurs., Mar. 27, 1958, in the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Organised by the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.7. Tel. KENsington 0048.

ENGINEERING MANUFACTURE

Technology of Engineering Manufacture, Conference.—Tues., Mar. 25, to Thurs., Mar. 27, 1958, at the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Organised by the Institution in conjunction with its Applied Mechanics Group and its Industrial Administration and Engineering Production Group. Apply to the Institution, as above. Tel. WHItehall 7476.

Electron and Nuclear Resonance in Chemistry, Applications of; and Recent Work on the Inorganic Chemistry of Sulphur, Symposia.—Mon., Mar. 31, to Wed., April 2, 1958, at Bristol. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

Japan International Trade Fair.—Sat., April 12, to Sun., April 27, 1958, at Osaka. Apply to the Japan International Trade Fair Commission, Honmashi-bashi, Higashi-ku, Osaka, Japan. See also ENGINEERING, July 5, page 27.

American Chemical Society, 133rd Meeting.—Sun., April 13, to Fri., April 18, 1958, at San Francisco. Organised by the Society, 1155 Sixteenth-street, Washington 6, D.C. U.S.A.

Radio Component Show, 15th Annual.—Mon., April 14, to Thurs., April 17, 1958, at Grosvenor House and Park Lane House, Park-lane, London, W.1. Annual private exhibition organised by the Radio and Electronic Component Manufacturers' Federation, 21 Tothill-street, London, S.W.1. (Tel. ABBey 4226.) No special preview will be held on this occasion. Applications for admission must be made in advance.

Factory Equipment Exhibition.—Mon., April 14, to Sat., April 19, 1958, at Earl's Court, London, S.W.5. Theme: "Modern Factory Equipment—Britain Challenges the World." Organised by Factory Equipment Exhibitions Ltd., 4 Snow-hill, Holborn-viaduct, London, E.C.1. Tel. CENtral 0354.

***Science in the Use of Coal, Residential Conference.**—Tues., April 15, to Thurs., April 17, 1958, at The University, Sheffield. Organised by the Institute of Fuel, 18 Devonshire-street, London, W.1. Tel. LANgham 7124.

***Liége International Trade Fair, Tenth.**—Sat., April 26, to Sun., May 11, 1958, at Liége, Belgium. *Agent:* Mr. R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

Electrochemical Society, General Meeting.—Sun., April 27, to Thurs., May 1, 1958, at New York. Organised by the Society, 216 West 102nd-street, New York 25.

***German Industries Trade Fair.**—Sun., April 27, to Tues., May 6, 1958, at Hanover. *Agents:* Schenkers, Ltd., Royal London House, 13 Finsbury-square, London, E.C.3. Tel. METropolitan 9711.

Engineering Societies in Western Europe and the United States, Conference.—Mon., April 28, to Sat., May 3, 1958, in New York. Apply to Colonel C. E. Davies, secretary, American Society of Mechanical Engineers, 29 West 39th-street, New York 18.

Institute of Metals, Jubilee Spring Meeting.—Mon., April 28, to Fri., May 2, 1958, in London; and Mon. and Tues., May 5 and 6, 1958, at provincial centres. Organised by the Institute, 17 Belgrave-square, Westminster, London, S.W.1. Tel. BELgrave 3291.

Prestressed Concrete, International Congress.—Mon., May 5, to Sat., May 10, 1958, in Berlin. Organised by the Fédération Internationale de la Précontrainte, Paris. Apply to Mr. P. Gooding, c/o the Cement and Concrete Association, Terminal House, 52 Grosvenor-gardens, London, S.W.1. Tel. BELgravia 6661.

***United States World Trade Fair, Second.**—Wed., May 7, to Sat., May 17, 1958, at the New York Coliseum, New York, U.S.A. Managers: The Charles Snitow Organisation, Inc., 331 Madison-avenue, New York 17. Information may be obtained from the British Commonwealth Chamber of Commerce in the United States, 677 Fifth-avenue, New York 22. The fair's British and Commonwealth office is at 36-38 Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

***Illuminating Engineering Society, Summer Meeting.**—Sun., May 11, to Wed., May 14, 1958, at Eastbourne. Display of lighting equipment at the Grand Hotel, Eastbourne, on May 11. Organised by the Society, 32 Victoria-street, London, S.W.1. Tel. ABBey 5215.

Production Exhibition.—Mon., May 12, to Wed., May 21, 1958, at Olympia, London, W.14. Organised by the Institution of Production Engineers. Apply to exhibition Offices: 32 Millbank, London, S.W.1. Tel. TATe Gallery 8134.

Gauge and Tool Exhibition.—Monday, May 12, to Wed., May 21, 1958, at Olympia, London, W.14. Organised by the Gauge and Tool Makers' Association, Standbrook House, 2–5 Old Bond-street, London, W.1. Tel. HYDe Park 3451.

***Castings Congress and Foundry Show.**—Mon., May 19, to Fri., May 23, 1958, in the Public Auditorium, Cleveland, Ohio. Organised by the American Foundrymen's Society, Golf and Wolf-roads, Des Plaines, Ill., U.S.A.

International Water Supply Association, Fourth Congress.—Sat., May 24, to Sat., May 31, 1958, at Brussels. Apply to Mr. L. Millis, O.B.E., International Water Supply Association, 34 Park-street, London, W.1. Tel. GROsvenor 1092.

***Large Electric Systems, International Conference on, 17th Session.**—Sat., May 31, to Sun., June 8, 1958, in Paris. Offices of the Conference: 112 Boulevard Hausmann, Paris.

***ACHEMA Chemical Engineering Exhibition.**—Sat., May 31, to Sun., June 8, 1958, at Frankfurt. Organised by DECHEMA, 25 Rheingau-Allee, Frankfurt-on-Main, Germany.

Solid State Physics in Electronics and Telecommunications, International Conference.—Mon., June 2, to Sat., June 7, 1958, at The University, Brussels. Apply to the honorary general secretary, Société Belge de Physique, Loveral, Belgium.

HIGH TENSION NETWORKS

High Tension Networks, International Conference on.—Wed., June 4, to Sat., June 14, 1958, at Fondation Berthelot, 28 Rue Saint Dominique, Paris. Organised by the Conférence Internationale des Grands Réseaux Electriques (C.I.G.R.E.). Apply to the secretary, British National Committee, Thorncroft Manor, Dorking-road, Leatherhead, Surrey. Tel. Leatherhead 3423.

Automation Exposition and Congress, Fourth.—Mon., June 9, to Fri., June 13, 1958, in New York. Organised by Richard Rimbach Associates, Management, 845 Ridge-avenue, Pittsburg 12, Pa., U.S.A.

British Electrical Power Convention.—Week commencing Mon., June 16, 1958, at Brighton. Theme: "Electricity and World Progress—Britain's Contribution." Organised by the British Electrical Power Convention, Eastcastle-street, London, W.1. Tel. MUSeum 4040.

***Electricity: Collective Economical Enterprises in the Public Section of the Industry, International Congress.**—Mon., June 16, to Fri., June 20, 1958, in Liége. Organised by the Association Liegeoise d'Electricité, 30 Rue des Augustins, Liége, Belgium.

Iron and Steel Institute Special Meeting in Belgium and Luxembourg.—Wed., June 18, to Sat., June 28, 1958, at Brussels, Charleroi, Liége, and Luxembourg. Organised by the Iron and Steel Institute, 4 Grosvenor-gardens, London, S.W.1. Tel. SLOane 0061.

Organisation of Chemical Engineering Projects, Symposium.—Tues., June 24, to Thurs., June 26, 1958, at Olympia, London, W.14. Organised by the Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. Tel. BELgravia 3647.

***Welding, International Institute of, Annual Assembly.**—Wed., June 25, to Tues., July 1, 1958, in Brussels. Offices of the Institute: 54 Princes-gate, Exhibition-road, London, S.W.7. Tel. LANgham 7488.

***Royal Institution of Chartered Surveyors, Annual Conference.**—Tues., July 1, to Sat., July 5, 1958, at The University, Exeter. Theme: "The Development of Land as an Investment for the Future." Offices of the Institution: 12 Great George-street, London, S.W.1. Tel. WHItehall 5322.

Steric Effects in Conjugated Systems, Symposium.—Tues., July 15, to Thurs., July 17, 1958, at Hull. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

High Polymers International Conference.—Mon., July 21, to Thurs., July 24, 1958, at The University, Nottingham. Organised by the Conference Secretariat, Department of Scientific and Industrial Research, 5-11 Regent-street, London, S.W.1. Tel. WHItehall 9788.

***Mathematicians, International Congress of.**—Thurs., Aug. 14, to Thurs., Aug. 21, 1958, in Edinburgh. Offices: 16 Chambers-street, Edinburgh 1.

***Australian and New Zealand Association for the Advancement of Science, 33rd Congress.**—Wed., Aug. 20, to Wed., Aug. 27, 1958, at Adelaide. Apply to Dr. R. S. Burdon, Department of Physics, University of Adelaide, Adelaide, South Australia.

Combustion, Seventh International Symposium on.—Thurs., Aug. 28, to Wed., Sept. 3, 1958, at Oxford University, and the Royal Institution, Albemarle-street, London, W.1. Organised by the Combustion Institute, 936A Union Trust Building, Pittsburg 19, Pa., U.S.A. Communications to The Combustion Institute Committee, c/o The Institute of Fuel, 18 Devonshire-street, London, W.1. Tel. LANgham 7124.

Future of Non Ferrous Mining in Great Britain and Ireland, Symposium.—September, 1958, in London. Sponsored jointly by the Institution of Mining and Metallurgy and the United Kingdom Metal Mining Association. Apply to the Institution of Mining and Metallurgy, 44 Portland-place, London, W.1.

Peaceful Uses of Atomic Energy, Second International Conference.—Mon., Sept. 1, to Sat., Sept. 13, 1958, at Geneva. Secretariat: 1 Place du Lac, Geneva, Switzerland. Apply to the secretary, the executive committee, 1958 Geneva Conference, Atomic Energy Research Establishment, Harwell, Berks. See ENGINEERING, August 16, page 218.

***Pan American Federation of Engineering Societies, 5th Convention.**—Tues., Sept. 2, to Sat., Sept. 6, 1958, at Montreal, Canada. Organised by the Engineers Joint Council, 29 West 39th-street, New York 18.

***Cybernetics, Second International Conference on.**—Wed., Sept. 3, to Wed., Sept. 10, 1958, at Namur. Organised by the International Association for Cybernetics, 13 Rue Basse-Marcelle, Namur, Belgium.

***American Chemical Society.**—Sun., Sept. 7, to Fri., Sept. 12, 1958, at Chicago, Ill., U.S.A. Organised by the Society, 1155 Sixteenth-street, Washington 6, D.C., U.S.A.

***Coal Petrology, First International Meeting on.**—Wed., Sept. 10, to Sat., Sept. 13, 1958, at Heerlen, Holland. Organised by the Committee on Coal Petrology, Geologisch Bureau, Akerstraat 86-88, Heerlen, Holland.

***Conservation of Nature and Natural Resources, International Union for.**—Thurs., Sept. 11, to Fri., Sept. 19, 1958, at Athens and Delphi, Greece. Sixth general assembly and seventh technical meeting. Union address: 31 Rue Vautier, Brussels, Belgium.

Large Dams, International Commission on, World Power Conference.—Mon., Sept. 15, to Sat., Sept. 20, 1958, in New York. Communications to the secretary, British National Committee on Large Dams, 201-202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966.

Gearing, International Conference.—Week commencing Mon., Sept. 22, 1958, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

***Gas Congress, Seventh International.**—Mon., Sept. 22, to Thurs., Sept. 25, 1958, in Rome. Organised by the International Gas Union, 4 Avenue Palmerston, Brussels 4, Belgium.

***Scientific Unions, International Council of, Eighth General Assembly.**—Thurs., Sept. 25, to Sun., Oct. 5, 1958, at Washington, D.C., U.S.A. Apply to Dr. A. Atwood, National Research Council, National Academy of Sciences, Washington, D.C., or to the International Council of Scientific Unions, 29 Tavistock-square, London, W.C.1.

COMMERCIAL MOTORS

***Commercial Motor Transport Exhibition, International.**—Fri., Sept. 26, to Sat., Oct. 4, 1958, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

Textile Machinery and Accessories Exhibition.—Wed., Oct. 15, to Sat., Oct. 25, 1958, at Belle Vue, Manchester. Organised by Textile Recorder Exhibitions Ltd., Old Colony House, South King-street, Manchester 2. Tel. Deansgate 6903.

Electronic Computer Symposium and Exhibition.—Fri., Nov. 28, to Thurs., Dec. 4, 1958, at Olympia, London, W.14. Apply to Mr. J. F. Richardson, technical secretary, Radio Communication and Electronic Engineering Association, 11 Green-street, London, W.1. Tel. MAYfair 7874.

***American Association for the Advancement of Science.**—Fri., Dec. 26, to Wed., Dec. 31, 1958, at Washington, D.C., U.S.A. Offices of the Society: 1515 Massachusetts-avenue N.W., Washington 25, D.C., U.S.A.

Engineering Exhibition (22nd Engineering, Marine, Welding and Nuclear Energy Exhibition).—Thurs., April 16, to Thurs., April 30, 1959, at Olympia, London, W.14. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

***Plastics Exhibition and Convention, International** (formerly the **British Plastics Exhibition and Convention.**—Wed., June 17, to Sat., June 27, 1959, at Olympia, London, W.14. Organised, with the support of the British Plastics Federation, 47-48 Piccadilly, London, W.1. (Tel. REGent 4681), by *British Plastics*, Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333.

***A.S.T.M. Third Pacific Area National Meeting.**—Week commencing Sun., Sept. 13, 1959, at the Sheraton Palace Hotel, San Francisco, Calif., U.S.A. Organised by the American Society for Testing Materials, 1916 Race-street, Philadelphia, Pa., U.S.A.

Engineering at Home

UNEVEN LIGHT

Indoor lighting changes the colour of things. Because of this, people will often take a piece of material out into daylight to make sure it has the colour they want. But this is not always logical. Some fabrics and materials in the home do not get viewed at all in the light of day; many are seen for the most part under artificial light. Such materials are best chosen in the same sort of light.

The Building Centre offers eight different kinds of lighting. They can be compared in the newly reconstructed electrical section—found on the first floor of the main building in Store-street, London, W.1. Designed as an aid to the choice of such things as fabrics, wall papers, and paint work, the feature also gives a guide to the various types of lighting available.

Identical cubicles are lit by the different types of lighting. The cubicles are small and arranged in two rows at eye level. They have an open side of about 21 in. wide by 18 in. high. A small piece of curtain material covers one wall and a piece of carpeting covers the floor. The remaining two walls are painted. In the centre of each cubicle stands a white plaster object. Light diffuses in through a glass ceiling.

At the press of a switch the cubicles are all lit with a conventional tungsten-filament lamp. The contents then look identical. After a few seconds the different types of lighting replace the tungsten. It is then possible to see the differences in apparent texture and colour caused by the variations of the colour spectra of the different lamp types. The following are used: daylight fluorescent, pink pearl tungsten, natural fluorescent, warm white fluorescent, de luxe warm white fluorescent, silica-coated tungsten, white fluorescent, and colour matching fluorescent. The last serves as a standard by enabling the true colours to be seen.

LOOKING FOR COMFORT

Research is to be made into the factors affecting comfort in upholstered furniture. The work has been made possible by a grant from the Dunlopillo section of the Dunlop Rubber Company to the Furniture Development Council, 11 Adelphi-terrace, London, W.C.2. Dr. Darcus writing in the *FDC Newsletter* says it will be a long-term job extending over at least three years. It is hoped that by then a fuller understanding of the scientific basis of comfort will be reached. "In fact," he says, "that we will discover what comfort really is. When that is known it should be possible to produce more comfortable upholstered furniture, cheaper and more efficiently."

Other research by the council includes work on tests for lacquers. Experiments are now being carried out and the scratch and abrasion test methods are nearly ready. The scratch test will measure the extent to which lacquer will mark superficially when rubbed with a rough material. The abrasion test will measure the extent to which lacquers wear away when polished or rubbed repeatedly with relatively soft materials.

SPRING FAIR

The Cologne International Spring Fair, 1958, will be a sequence of three trade fairs. Consumer goods from most European countries will be shown. As far as can be seen at present, the fair will occupy a floor space of 225,000 sq. yd.

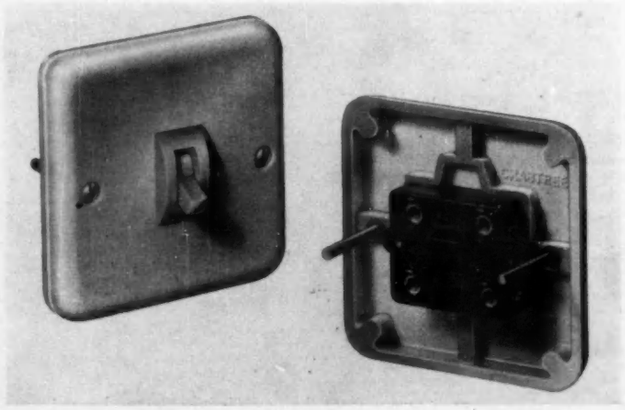
The Spring Fair will open with the Furniture Fair, which will be held from February 7 to 11. Firms from 16 other European countries will compete with the German furniture manufacturing industry. At the Household Goods and Hardware Fair, from February 28 to March 3, over 1,000 exhibitors will be showing their latest developments. Twelve to 14 other European countries are expected to take part. The final fair is the Textile and Clothing Fair from March 9 to 11.

During recent years the International Household Goods and Hardware Fair in Cologne has developed into one of the most important markets for its field. The last one was visited by over 40,000 buyers from 64 countries. At it, Italy was able to sell Espresso machines to Belgium, Canada, Denmark, Finland, France, and Great Britain; Japan offered porcelain and stoneware goods, baskets and wickerware, toys and gift articles, and also sewing machines and optical goods; a Swedish producer exhibited door-closers, ripping chisels, steel planes, and domestic and vocational knives—he expects an increasing turnover on the West German market; a Danish firm offered lawn mowers; Swiss exhibitors offered—amongst other things—massaging apparatus and fresh air appliances; and British firms showing washing machines, spin dryers, refrigerators, anti-draught strips and metal cutters expect increased sales prospects on the West German market.

SHALLOW SWITCH

A new addition has been made to the range of Linclon type alternating current flush switches manufactured by J. A. Crabtree and Company, Limited, Walsall, Staffordshire. The new model is the Intermediate switch.

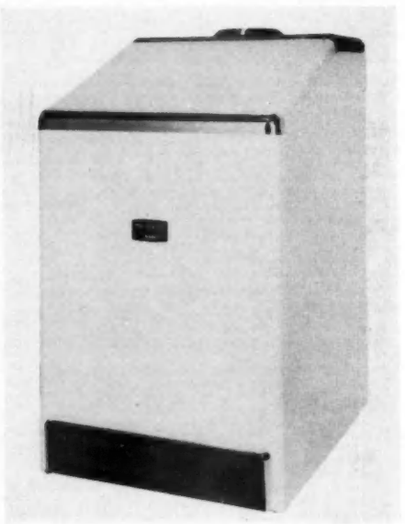
As can be seen from the accompanying illustration, the switch has a very small back projection. The contacts are of beryllium copper and have pure silver buttons. Only the wiring terminals are freely accessible; the mechanism, moving on nylon pivots, is sealed. The switch is rated at 5 amperes 250 volts a.c.



The Crabtree Intermediate switch has a shallow back projection and can be erected in boxes of plaster depth.

OIL-FIRED DOMESTIC BOILER

A low-cost automatic oil-fired boiler, designed for providing central heating and hot water supplies for the average four-bedroom house, has been introduced by the Potterton Division of Thomas De La Rue and Company Limited, De La Rue House, 84/86 Regent-street, London, W.1. Known as the Potterton COA-53 boiler, it has a rated output of 53,000 B.Th.U. per hour and is designed to burn 35 second oil, the cheapest oil fuel available for domestic use.



The COA-53 oil-fired boiler is a complete unit containing a cast-iron sectional boiler with an integral draught stabiliser.

Like other Potterton oil-fired boilers, the COA-53 is a complete unit comprising a cast-iron sectional boiler with an integral draught stabiliser, a pressure-jet burner with photo-electric control, and a thermostat. The boiler is supplied with the burner and controls pre-wired ready for assembly, and the whole unit is enclosed in a sheet-steel case available in a choice of four colours. The standard finish is hammer-blue stove enamel, the alternatives are cream, white or kerry-blue enamel with chromium trim.

CLEARING THE AIR

Last year undistributed stocks of gas coke amounted to 1½ million tons. This year the corresponding figure is 2½ million tons. "It does not need a financial genius to deduce from these simple figures the fact that there is a great supply of gas coke available for increased use by the domestic consumer," said Mr. David Renton, Parliamentary Secretary, Ministry of Power. He was speaking at a reception to launch the Gas Council's new *Coke-Burning Appliances Handbook*.

The book has been compiled to assist those concerned with the application of the Clean Air Act, and to simplify the problem of appliance selection. About 300 approved appliances are listed in the handbook. The term "appliances" covers such things as open fires, heating stoves, domestic boilers, small central-heating boilers, and cookers. Technical data on coke are given and the British standards relevant to the subject are listed. Co-operation by the manufacturers of the appliances has made it possible to give the heat service provided by each appliance. Further guidance to selection is given in a section "Selection of Appliances." The handbook is available from Area Gas Boards or from the Gas Council Coke Department, Grosvenor-place, London, S.W.1. It costs 15*s*.

Marketing

INTEGRATION ACROSS FRONTIERS

A Swedish diplomat, Mr. Torsten Vinell, who for many years has concerned himself with his country's export performance, talked recently to the General Export Association of Sweden on " The New Era " in world trade, and particularly of likely developments in European trade during the next decade. Most of the basic ideas Mr. Vinell puts forward are in the minds of most business men in Britain at the present time. " Now it seems," he said, " that Great Britain is growing steadily closer to Europe and is making Europe's cause her own. For those with ears to hear, the wing beats of fate are unmistakable." Politically Mr. Vinell implies, there is no alternative to the free trade area, i.e., to a western Europe economically integrated and strong enough technically and commercially to compete in world markets, to secure its raw material supplies and to hold its own in the developing struggle between the great powers for the political allegiance of the developing areas of the world—a subject dwelt upon in our leading article the week before last.

Sweden's position differs little from Britain's; there is a pressing need on the part of Swedish industry for a closer association with industries of other European countries. The implementation of a free trade area, with gradually diminishing obstacles to trade between nations within it, will make this possible. Above all it will make possible the integration of companies located anywhere in the area. The logical outcome of a political movement towards European integration is the elimination of frontiers, with a consequent increase in the movement of labour and capital as well as of goods. For the vast mass of European industry a process of rationalisation will impose itself and will carry with it a certain amount of specialisation on a country basis. It will also lead to the creation of trade areas independent of frontiers, e.g., Flanders, embracing Northern France and Benelux; the Rhine valley; the Mediterranean basin, etc. The firm with the best chance of success will be the firm with subsidiary or associated companies throughout the free trade area.

Already there is a trend towards the extension of the interests of large companies across European frontiers. Fiat, for example, now control Simca, who are one of the four main producers of private cars in France. Ford and General Motors have plants in both Britain and Germany and already there is talk of further integration until the 20-odd firms making cars in the eleven countries of the proposed free trade area has been reduced to five or six. Increasingly licences are being obtained and issued by British, German, French and Italian firms which provide them with common products and pooled development resources. But the process will go further. Financial integration of companies now competing within the proposed free trade area is inevitable for only thus will the economies of scale, the capital investment and the co-ordination of marketing efforts in export markets be realisable.

* * *

Financing World Trade

The problem of supplying extended credit to overseas buyers of engineering products is becoming more acute, and more pressing, as the Russian intentions to compete become more clearly defined. There is a need for much closer co-operation on the part of the main exporting countries in the western hemisphere, and the suggestion is made in the November issue of the *Barclays Bank Review* that this should be done through the International Monetary Fund.

The operations of the Fund are reviewed and the idea that it should operate as a bank is examined. In this way, it is suggested, the Fund could function as a clearing mechanism where periodic settlements could be arranged between members in much the same way as in the European Payments Union. Settlements could be made partly in gold and partly by an extension of credit, thus giving debtor nations automatic access to credit within agreed limits and, more important, putting an obligation on member countries in surplus with the Fund to extend credit: " Such an innovation would seem to be a logical step in the development of the finance of world trade." Private capital could be directed through the Bank and thus assure the abundance of funds which will be required in the next few years if the West is to take up effectively Russia's challenge.

* * *

Canadian Mission

A large and high-powered trade delegation arrived in this country last week " to explore the possibilities of increasing the volume of trade between our two countries by switching a portion of our imports from the United States to the United Kingdom." These terms of reference were defined by Mr. J. S. Duncan, deputy-chairman of the delegation which includes 55 business and Government representatives. He went out of his way to emphasise that this was " in no sense just an anti-American move." Clearly there is a need for Canada to find markets for her exportable surpluses, particularly agricultural products and raw materials.

The mission's arrival will coincide with a fall in activity in most sections of the Canadian economy. Yet there is a widespread belief that the mission's work will result in a substantial expansion of British exports to Canada over the next two or three years. It is Canada's answer to Britain's request for an Anglo-Canadian free trade area which was so decisively turned down at Mont Tremblant in the autumn. Its immediate success will depend to a large extent on Canada's ability to live up to Mr. Diefenbaker's predictions that it will rise from the present plateau of activity " to greater heights of economic progress than ever before."

* * *

Demand for Heavy Machinery

The Canadian mission will pay particular attention to the possibility of increasing imports of heavy machinery and engineering products which have a high labour content. Already there is a trend in this direction. In the first nine months of this year imports of machinery (£29·3 million) and of iron and steel products (£14·2 million) were 16 per cent. above the previous year's level and accounted for nearly 30 per cent. of total British exports to Canada.

Among the scheduled visits to be made by the Mission, which will divide into parties for the purpose, are over 40 steel and engineering firms out of the 60-odd companies that have been named. This proportion will almost certainly be increased when visits by small groups and individuals to firms in which they are particularly interested are included. There are groups of products, including instruments made in this country under licence from United States companies, which can be sold in North America more than one-third cheaper than they can be produced locally. Similarly, both fabricated steelwork and cement can be delivered from the United Kingdom at a price less than the local product. All manufacturers must not forget, however, that they have little chance of selling anything, irrespective of price, unless they are prepared to finance and organise first-class after-sales service and to make a detailed study of the design requirements of the Canadian market.

* * *

Television Advertising for Engineers

The interest in television as a medium for advertising was clearly demonstrated at the British Institute of Management's annual conference in Bournemouth when a paper entitled " To Advertise on TV—or Not? " was read to a packed audience. The presence of many manufacturers of plant and machinery suggested that there exists in the capital goods industries a growing interest in this medium. Yet the first advertisement by such a company was on November 13 on the Birmingham Commercial Television Station. For 30 seconds at a peak viewing time, Westool Limited put over various aspects of machine tool control possible with the help of their Warner electromagnetic brakes and clutches. It is too early to discuss reactions, but the company's invitation to " interested viewers " to write for a new brochure (presumably produced for the occasion) should yield useful information on the breadth of impact if not on its depth.

The B.I.M. paper was presented by Mr. B. F. Maccabe, the chairman and managing director of the advertising firm of Foote, Cone and Belding. He had much to say about the limitations of television advertising and about the imperfections of the advertising material put forward. Also, he pointed out that many advertisers on television had become " too emotional about it " and that cool heads were required to assess its suitability despite the fact that " there is magic about this medium that must not be underestimated." His advice was, " first, work out your marketing plan, then select whichever media most closely match that plan's requirements." In some cases the answer will be to use television—in others it will not.

* * *

Background to Decision

The role of market research as the background to decision was the theme of another of the papers presented to the B.I.M.'s national conference by Mr. M. St. G. Lyster, the managing director of Marketing Trends. It was also the subject of a good deal of discussion in hotel lounges and by study groups. Keen interest was displayed by manufacturers of capital goods, but knowledge of applications and techniques was sadly lacking. They came to hear the paper and subsequently to discuss the subject because they wanted to discover " what it was all about."

Mr. Lyster spoke primarily of research into consumer markets, since very few market research organisations have on their staff the qualified engineers with industrial experience required to operate in capital goods markets. Perhaps the most interesting of his remarks came when he was discussing motivation research: " . . . I would say that it is indeed important, even vital, to know just what are the reasons lying behind the purchase of your product. The real reasons may well be highly involved and require special steps in order to resolve them." Why a firm buys component or product *A* rather than *B*—generally a complex of reasons often not clearly understood by the persons concerned, resulting in a decision to which several (designers, production engineers, buyers, managing directors and others) have contributed—is vital to those responsible for designing, making and selling it.

Success comes rarely in a competitive market to those who cannot " marry " the technical to the commercial and who cannot plan production some way ahead. Market research, properly used, can make this possible and therefore solve the problems Mr. Lyster defines as those " relating to which market to enter, to the product to be produced, to the quantity to be produced, and to the means by which the product is to be distributed."

Book Reviews

MOBILE BED HYDRAULICS

Régime Behaviour of Canals and Rivers. By T. BLENCH. *Butterworths Scientific Publications*, 88 *Kingsway, London, W.C.2.* (30*s*.)

Régime theory, in its modern form, may be said to date from 1929 when Mr. Gerald Lacey formulated the principles underlying the stability of channels in erodible materials. Briefly, Lacey established that nature provided three distinct laws of self-adjustment of régime canals, one related to depth, one to breadth, and one to slope, and he found that he could express them all in terms of the discharge and a single omnibus silt factor which embraced not only the size of the bed material but also the quantity in transport.

The first two of these laws, that breadth varies as the square root of the discharge and depth as the cube root, have been confirmed by an analysis of voluminous river-discharge observations made in America. On the other hand, the slope data do not, at present, permit of any deduction being made regarding the third law, that slope varies inversely as the sixth root of the discharge, though that relationship is generally accepted.

The term " régime " has a specialised meaning, but it is more commonly used to denote stability. A stable channel, or a channel " in régime," may be regarded as one which does not alter appreciably from year to year, and the " régime condition " as one of equilibrium in respect of scour and deposit over the whole wetted boundary, irrespective of the load of transported sediment. In his new book, Professor Blench uses the term " in régime " in that sense, but he also uses the word in a more general way. He so describes a river to distinguish it from one that cannot adjust any portion of its boundary, but without any implication that it is technically " in régime."

Professor Blench has been engaged in the study and practice of canal and river engineering for over 30 years—prior to 1947 in the Punjab, and subsequently in the United States and Canada. He refers to his book as the first formal text-book on the science of mobile boundary hydraulics and no one is better qualified to write such a book. He subscribes to the Lacey laws, but his method of treatment is individual. He claims that it is necessary to separate the effects of the sides and bed, on the grounds that channel sides that carry no sediment, and are cohesive, do not contribute to régime in the same manner as does the bed. He does this by using two factors, one a bed-sediment factor, which is a generalised form of the Lacey silt factor and is expressed in the same way, in terms of a Froude number, and the other a side factor.

Professor Blench has written extensively elsewhere on the dynamical aspect of régime forms and he has included an excellent chapter on the subject in his book. He uses a generalised form of the Blasius equation for smooth, circular pipes to define régime slope which leads to a velocity-slope relation in terms of both bed and side factors, in contradistinction to the Lacey relationship which is in terms of the bed factor alone.

The main development in régime theory in recent years has been in regard to the effect on the relationships of the quantity of material in movement relative to the magnitude of the discharge. In 1947 Sir Claude Inglis modified the Lacey relationships and expressed them in terms of the solid volume of sediment transported, the terminal velocity and the diameter of the sand grains forming the sediment. Professor Blench expresses the effect of sediment load not only in his bed factor, as in the Inglis formula, but also as a separate factor in his slope equation, thus changing that equation from one in which the régime conditions were implicit. This may seem to some engineers to be a retrograde step.

The Blench and Inglis-Lacey slope equations give the same slope at a point within the sand range represented by a Blench bed factor of unity and a side factor of one-fifth; but on either side of that point they diverge, the Inglis channels requiring greater slopes when the side factor increases beyond the sand range, for which his formula was designed. In rivers, though the discharge and bed load of sediment may vary considerably, the slope and sectional shape are still largely determined by what Inglis calls the dominant and Blench the formative discharge and load.

The applicability of the régime equations to rivers is dealt with in detail in the book and much information of a practical nature is included on such matters, for example, as river meanders, scour at bridge piers, waterway at bridge sites and river training works. There is also a particularly good chapter on river models.

The book brings together many items of river information which, though well known to the specialist, may not be so well known to other engineers, and it should appeal alike to the student and the practising engineer. The book jacket states that the aim of the book is to help the practising engineer to solve problems that may arise in dealing with canals and rivers that form their boundaries from sediment and do not submit to arbitrary interference. It not only succeeds in its aim but fills a gap left by most text-books in their treatment of mobile boundary hydraulics.

The author has kept his book free from detailed qualitative descriptions, controversies and alternative methods that are not essential to the main aim, but has provided a carefully selected bibliography from which they can be found.

AMERICAN CONVEYORS, HOISTS AND TRUCKS

Materials Handling Equipment. By D. OLIPHANT HAYNES. *Chilton Company Incorporated, Philadelphia* 39, *Pa., U.S.A.* (6 dols.); and *Bailey Brothers and Swinfen Limited*, 46 *St. Giles High Street, London, W.C.2.* (140*s*.)

Engineering; mechanical engineering; mechanical handling—these terms form a narrowing range of activities and interests. Yet even within the most specialised of these three subjects an engineer may, without restricting himself unduly, spend a useful working life on the development of fork-lift trucks and know less about the specification for a conveyor belt or about devices for sorting postal packets than he does about economics or the law.

So it is with books on mechanical handling. Few of them cover the whole field, and authors usually take pains, when defining the subject, to limit their interpretation of it. After discussing the terms " materials " and " handling " individually, Mr. Haynes states in the preface that " Materials handling embraces the basic operations in connection with the movement of bulk, packaged, and individual products in a semisolid or a solid state by means of gravity-, manually- or power-actuated equipment and within the limits of an individual producing, fabricating, processing, or service establishment." To arrive at this definition, he specifies a number of exclusions, and it should be noted that the term " materials handling " is generally slightly broader than the more common term " mechanical handling."

For most purposes of study, and indeed for the purpose of this book, the author's definition is still far too wide to be covered thoroughly, yet, in another sense, this book needs a widely ranging title, as it is almost entirely an annotated list of materials-handling equipment commercially available in America from about 170 firms whom the author lists, under the heading "Acknowledgements," early in the book.

This method of compiling and presenting data —by following closely the sales literature of a large number of manufacturers—results in a very uneven treatment of the subject. Many types of trucks, for example, having found a sufficiently wide market, have been highly developed as standard commercial equipment and are in consequence described at a length and to a degree of detail quite disproportionate to their importance in the subject as a whole. Several other classes of materials-handling equipment, important if only because they solve handling problems by ingenious and unusual methods, are not referred to at all, presumably because they cannot be bought " off the shelf." Among these, machinery like hopper feeds and mechanical hands, for feeding components to press tools or to machine tools, and devices for handling paper sheets or reels at printing or packaging machines, come to mind readily.

Because of its origin the numerical data, such as sizes, load capacity or speed, quoted in relation to any given type of equipment, are not based on any general theory of construction or use of such equipment as a type but pertain to specific models; such information does little to create a comprehensive, orderly picture in the reader's mind.

The publishers suggest that the book is intended for executives in the plant or the warehouse, and, surprisingly perhaps, for the salesman of materials-handling equipment who, in recommending a new conveyor " is expected to be able to co-ordinate his product with equipment planned or already in use." They also state that " this book particularly is valuable for salesmen, in adult extension courses, teachers of courses in this subject, and students. Nowhere else can such a comprehensive graphic presentation of the subject be found." It is unlikely that the book will meet all these claims. An executive as a potential purchaser, anxious to make a correct choice from available standard or near-standard equipment, will find the book helpful by having his attention drawn to constructional detail and features of performance which he can hope to find. The materials-handling equipment salesman will gain a useful impression of the state of his market, and of the position of his equipment in relation to that of his competitors. Used for this purpose, the book will obviously be much more useful to readers concerned with American equipment than to those interested in equipment made elsewhere. Teachers and students, who may wish to know not only what is being done but also what could be or is likely to be achieved in this subject, will probably be disappointed.

It should be emphasised that design details of existing equipment are well shown, that line drawings are numerous and exceptionally clear, and that numerical data, though scanty even within the limitations outlined above, are lucidly presented, often in tabulated form. There are many useful warnings against misusing the equipment described, and the need for proper maintenance is frequently stressed.

There is an appendix on the vector analysis of forces, and another on simple machines, each treating its subject in a very elementary manner. There is a good list of contents, and a very comprehensive 20-page index which is carefully cross-referenced.

NEW BOOKS

Analysis of Indeterminate Structures. By JAMES C. GRASSIE. *Longmans, Green and Company, Limited, 6 and 7 Clifford-street, London, W.1.* (50*s.*)

The graphical and analytical methods available from the determination of elastic deformations in solid and framed structures are given in this new book by Mr. Grassie. Strain energy as well as area moment and slope deflection methods are discussed; reference is also made to moment distribution and column analogy methods. Among the particular topics dealt with are rigid frames, statically indeterminate trusses, elastic arches and continuous and long-span bridges. The book is intended primarily for engineering students taking university examinations in the theory of structures and the corresponding examinations of the professional institutions. Worked examples are also intended to make the book useful to men working in design offices.

Agricultural Rheology. By G. W. SCOTT BLAIR and MARKUS REINER. *Routledge and Kegan Paul Limited, Broadway House, 68-74 Carter-lane, London, E.C.4.* (28*s.*)

The deformation and flow of materials—rheology—has become a well established branch of physics during the last 25 years. This present volume sets out to present well-established data for the particular use of agriculturalists. A broad introduction is given to fundamental theory in the first part of the book; the second part deals with a number of applications. These applications may be considered in two parts: in respect of the soil which has to be ploughed and otherwise worked; and in respect of crops and livestock. Descriptions are given of apparatus required to make the relevant determinations.

The Investigation of Atmospheric Pollution. A Report on Observations in the Year Ended 31st March, 1955. Twenty-Eighth Report of the Department of Scientific and Industrial Research. *Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.* (5*s.* 6*d.*)

The figures given in the report, which covers a large number of towns, both industrial and otherwise, during the year ended March 31, 1955, were obtained before the Clean Air Act came into force, and may therefore be used as a basis on which the effects of the Act can be assessed. The average deposition of dust and grit is much the same as in the previous five years, being about 230 tons per square mile per year, but in the most heavily polluted areas figures as high as 1,175 tons were obtained. The report also includes brief details of current investigations by the Fuel Research Station, including factory premises and the pollution of the air by exhauts gases from motor vehicles.

The Structure of Steel. By EDWIN GREGORY and ERIC N. SIMONS. *Odhams Press Limited, 96 Long Acre, London, W.C.2.* (18*s.*)

Dr. Gregory and Mr. Simons have established a reputation for their books on metallurgical subjects written as far as possible in simple non-technical language. The present volume is the third edition of a book bearing the same title and first published in 1938. Its sub-title is: "A Simple Explanation for Students, Engineers, and Buyers of Steel." As the authors state, research and development do not stand still and much has happened in metallurgy during the past 20 years. The original text, therefore, has been revised and brought up to date so as to include modern laboratory testing methods, new heat-treatment techniques and other recent developments.

Glass Reinforced Plastics. Edited by PHILLIP MORGAN. Second edition. Published for *British Plastics* by *Iliffe and Sons Limited, Dorset House, Stamford-street, London, S.E.1.* (45*s.*)

The first edition of this work, which sets out to present the facts on the two raw materials involved, namely, the resins and glass, was published in 1954 and a second and a third impression were issued in 1955. In the present, second, edition the text, which describes the fabrication techniques now in use and discusses some of the problems of specialised applications, has been revised and many of the original chapters completely re-written. In addition there are entirely new chapters on epoxide resins, on the resin injection-moulding process, and on chemical-plant applications.

Determination of the Viscosity of Liquids in C.G.S. Units. B.S. 188 : 1957. *British Standards Institution, 2 Park-street, London, W.1.* (10*s.*)

First published in 1923 to encourage the expression of viscosity in c.g.s. units rather than in arbitrary units depending on the instrument used, this British Standard has been revised twice, the last time in May, 1937. The progress made in viscometry during the past 20 years has necessitated a third revision which has now been issued. The most important change made in this new edition is that water is now the sole reference liquid, and every capillary viscometer is to be directly or indirectly calibrated against water at 20·00 deg. C. It is further stipulated that the dynamic and kinematic viscosities of water at 20 deg. C. shall be accepted as 1·0020cP and 1·0038cS, respectively.

Bibliography on the Continuous Casting of Steel (1934-1957). Bibliographical Series No. 21. Prepared by the Library and Information Department of the *Iron and Steel Institute, 4 Grosvenor-gardens, London, S.W.1.* (*Non-members* 25*s.*; *members,* 15*s.*)

During the past few months an increasing amount of interest has been manifest in the continuous casting of steel and it is to help to meet the demand for information on this subject that the present *Bibliography* has been prepared and issued. It covers in chronological order all the references in the literature to the process for the past 25 years or so, with fairly lengthy abstracts of each article, paper or report. There are many descriptions of the recent Russian work, from the original sources. Indexes to authors, to processes and to the plants in operation have been included.

General Workshop Exercises. Part I. By H. ROLLINS and A. E. BELL. *Edward Arnold (Publishers) Limited, 41 Maddox-street, London, W.1.* (14*s.*)

This collection of exercises has been compiled with the three year course to the Intermediate Certificate of the City and Guilds in mind. Thus, the first part is intended to cover first year work and the more elementary portion of the second year work. The division, however, is somewhat arbitrary. The volume is divided into workshop techniques, and gives brief outlines of good current practice, followed by a series of 19 bench exercises to enable the student to put these techniques into practice. The last section of the volume comprises the appendices, which include sketches and tables of drill numbers and the like.

Servicing Guide to British Motor Vehicles, Volume 4: Cars, Commercial Vehicles, Diesel Engines and Components. By A. J. K. Moss. Published for *Motor Trader* and *British Automobiles Overseas* by *Trader Publishing Company, Limited, Dorset House, Stamford-street, London, S.E.1.* (57*s.* 6*d.*)

The presentation of the material in this volume differs from preceding ones in order to give a wider range of data. The major difference is that the standard proprietary components are reviewed separately in detail, and in addition, proprietary Diesel engines are also treated as separate components in view of the number of different applications in which they are employed. The exploded type of illustration is used throughout for all major units. Some 40 different models of cars and commercial vehicles are covered by the 22 service data sheets included, and there are 18 articles on the servicing of components, concerning some 25 types ranging from carburetters to automatic transmissions.

On the Shelf

By Frank H. Smith

Once again I have received that massive tome from the Massachusetts Institute of Technology which they describe as the Bulletin (for the current year) and General Catalogue Issue (for the following year). I commend it to all those concerned with the various Advanced Colleges of Technology in this country, both built and contemplated, that they may approach their tasks with due humility. The book contains 372 pages and any attempt in this column to review its contents would be presumptuous and hopeless. The first 29 pages cover general information, pages 31 to 43 undergraduate education, 49 to 61 graduate education, 65 to 66 school for advanced study, 67 to 72 school of architecture and planning, 75 to 124 school of engineering, 125 to 138 humanities and social studies, 141 to 151 industrial management, and 152 to 181 school of science. Quite by chance I turned to pages 107 and 108 and found listed the staff of the Department of Mechanical Engineering, comprising 60 professors and assistant professors, 1 lecturer, 15 instructors, 5 technical instructors, 3 research associates, and 15 professors emeriti.

I was delighted to read Mr. Leslie Wilson's letter to the Editor on page 520 of our issue for October 25. In this he points out the fallacies of my reasoning with regard to contributors to Aslib and the function of the information department. Let us try a different tack.

It would seem that some libraries receive so many inquiries for material which they do not hold (and presumably do not intend to get) that the strain of requesting this from other sources is too much for the typing department. The result is that, instead of an issuing body receiving a courteous letter starting Dear Sir, or Dear Mr. Tonks, or Dear Charlie a horrible formal *printed* form is sent out and this varies between the wheedle and the downright peremptory. I may be old-fashioned but I do deplore this reduction of courtesies to a bureaucratic form and I feel it indicates the reduction of the librarian, as a man in charge of printed material, to a bibliographic go-between.

I have remarked before (and shall no doubt do so again) concerning the danger of blindly choosing by title. For instance, List No. 844 of the Lending Library Unit of the Department of Scientific and Industrial Research has a title *Development of a New Oxford for Navy Women.* Should this strike you as carrying recruiting for the WRNS a bit far, let me assure you that it is a report by the United States Navy on shoes. I believe the United States Navy women are called "Waves" which, in turn, could lead to some confusion with an item in list 848. It is *Wave Propagation in Solids.* The book is, in fact, concerned with soil mechanics, but, it all goes to show doesn't it?

Interscience Publishers in sending out reminders for subscription renewals to *Communications on Pure and Applied Mathematics* are almost apologetic in telling subscribers that there will be a slight increase in the price. What is even more extraordinary is that they do not blame increased costs of paper, wages and all the other usual excuses. No, it is because the next volume will have *more pages !*

I am always intrigued when I see foreign journals printing English expressions in our own language (an example is, of course, *le* "five o'clock") and I am happy to notice that the Germans refer to *die* "Bristol Bloodhound," thus proving that it is not a dog; if you see what I mean.

It is rarely, nowadays, that any organisation publishes yearly returns that show a decrease on the previous year. It is, therefore, surprising to see that the 1956-57 figures of business at the National Central Library are almost without exception lower than those for 1955-56. Of the applications received, applications dealt with, and the various classes to whom volumes were issued (libraries in different categories, welfare organisations, etc.) only one—individual readers—does not show a lower figure. This particular total remains unaltered at 29. Strangely enough I cannot see the blame put on television anywhere in the report.

There is a special issue (what, I believe, the French call *hors série*) of the *Esso Magazine* devoted to "Energy and Man." This does not, of course, refer to pep pills but to sources and application of energy. Contributors include Sir Harold Hartley ("What is Energy"), Professor C. Payne-Gaposchkin of Harvard ("Energy in the Universe"), Professor A. R. Ubbelohde ("Basic Sources of the Earth's Energy") and many other authorities. The 47 pages are illustrated to the usual high standard one has come to expect of oil-firm publications.

Design

200,000 LB. CYCLONE-FIRED BOILER

COMPACTNESS WITH HIGH EFFICIENCY

Some three years ago the decision to install a titanium melting plant at the Kynoch works of the Metals Division of Imperial Chemical Industries, Limited, made it imperative to increase the output from the private power station. Space limitations necessitated that this new plant had to be more than usually powerful for its size and should operate with a minimum of smoke and dust, owing to its situation in a partially residential area.

This problem was dealt with by installing a Cyclone-fired boiler, manufactured by Babcock and Wilcox Limited, 209 Euston-road, London, N.W.1, the output of which is 200,000 lb. of steam per hour at a pressure of 950 lb. per sq. in. and a temperature of 925 deg. F. at the superheater outlet. Since this boiler was commissioned about a year ago it has operated at an efficiency of nearly 90 per cent., burning coal of such low quality that it could not be used in conventional plant. Moreover, the ash produced is in the form of granular slag and, being readily usable for civil engineering purposes, has solved a disposal problem. Fly ash, too, has been considerably reduced. The high efficiency is due to the fact that a Cyclone boiler operates best on about 8 per cent. excess air, compared with the 25 per cent. that is theoretically necessary for the complete combustion of fuel in other patterns. The result is a considerable reduction in the quantity of heat and smoke discharged from the chimney with a corresponding lower loss in energy. The results of an efficiency guarantee test on this boiler are given in the accompanying table.

The fuel used in this installation is obtained from Midland coalfields and has a gross calorific value of 9,545 B.Th.U. per lb. It is taken from the existing boiler-house bunkers to four vibratory feeders, each with a maximum rating of 8 tons per hour, and thence to a belt conveyor with a capacity of 16 tons per hour. This

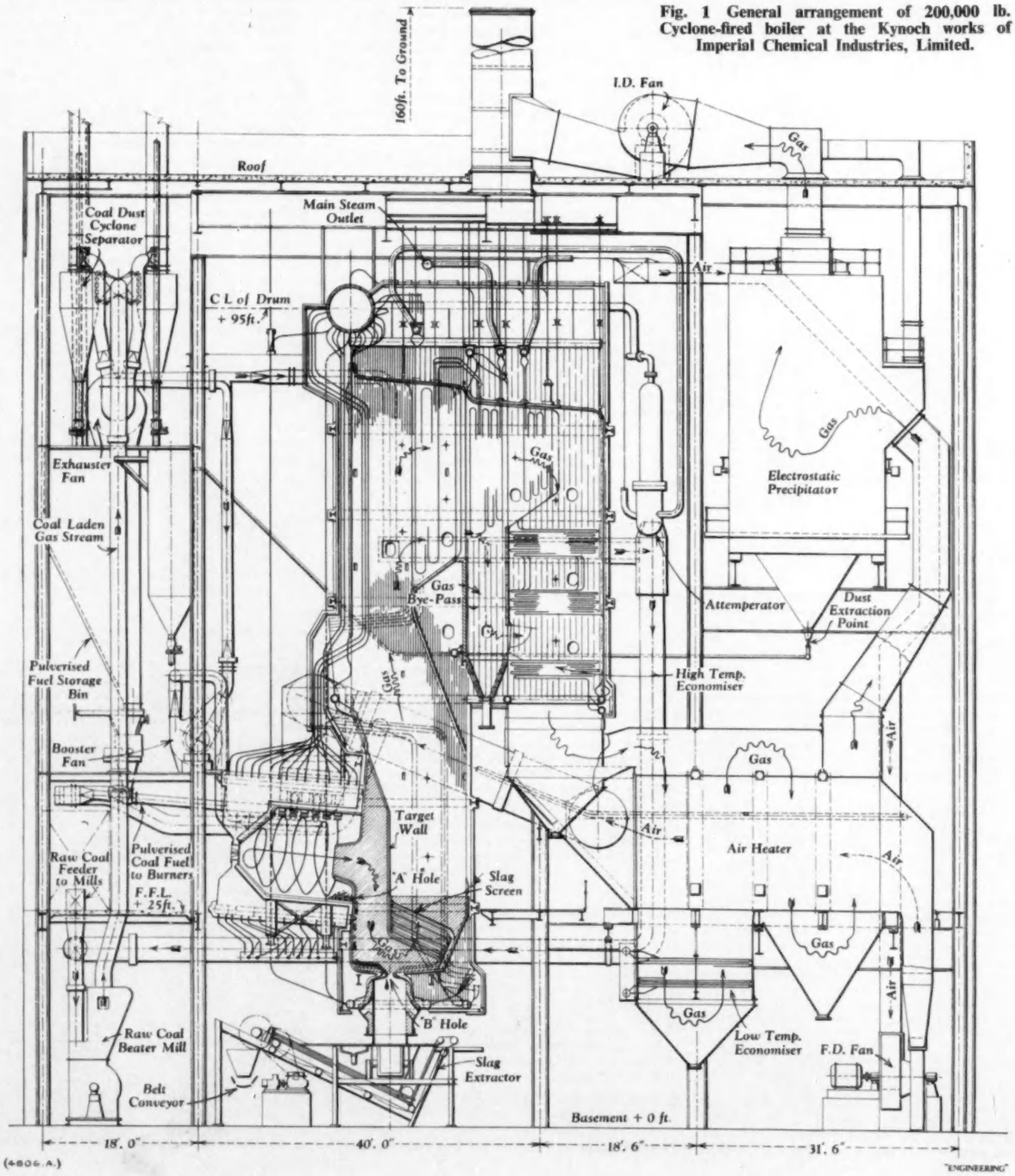


Fig. 1 General arrangement of 200,000 lb. Cyclone-fired boiler at the Kynoch works of Imperial Chemical Industries, Limited.

conveyor delivers into a buffer hopper with a maximum capacity of 14·75 tons. To ensure a positive head above the outlet of this hopper the minimum capacity is limited to 6·75 tons and, in the event of the contents falling below this quantity, the vibratory feeders are shut down. From this hopper the coal flows into a drag-bar feeder from which a single pulveriser of the beater mill type is supplied.

After being coarsely pulverised in this mill, the position of which is shown on the general arrangement drawing reproduced in Fig. 1, the coal is borne on a stream of inert gas to dust separators and thence into the pulverised fuel storage bin, as shown on the same drawing. It is subsequently passed to the Cyclone furnace through four feeders, the speed of which can be varied so that the coal supply, and hence the boiler output, can be closely controlled. There is also a manually operated oil lighting-up burner.

FURNACE DESIGN

The pulverised coal and primary air are admitted tangentially at the outer end of the furnace, as shown in the longitudinal section given in Fig. 2, and swirl forward to meet a high velocity tangential stream of secondary air, which is introduced at the top. The temperature within the furnace is high enough to melt the ash which clings to the inner surface of the Cyclone, thus forming a continuous coating of molten slag that flows slowly down to the discharge outlet at the lower end. A small amount of cooling air is introduced into the nose of the Cyclone to assist in keeping this locality clear of slag. This cooling air forms part of the total combustion air. The larger particles are flung by centrifugal force on to the slag coating where they burn rapidly under the scrubbing action of the high velocity secondary air, any residual ash melting into the slag.

Efficiency Guarantee Test

Heat account Based on Gross C.V.	Per cent.
Gross efficiency (by difference)	88·10
Losses:	
1. Dry gas	3·69
2. Moisture	5·37
3. Combustible in slag	0·02
4. Combustible in grits	—
5. Slag tank quenching	1·32
6. Radiation and unmeasured (assumed) ..	1·50
	100·00

The slag formed on the walls of the furnace flows through "A" hole, the position of which is shown in Fig. 1, into the secondary chamber and then through "B" hole into an extractor, consisting of an electrically driven drag-scraper conveyor. This extractor is cooled by water admitted through four nozzles (Fig. 3) arranged to give a circular motion below the surface. The breakage of any large pieces of slag is thus ensured. At the end of the conveyor the ash falls through a grid into one leg of a bifurcated chute so that any oversize material is directed to emergency trucks, while the remainder is delivered on to a second conveyor which carries it across the basement to an existing water immersed discharge conveyor.

After passing through the Cyclone throat the high temperature gas is deflected downwards by a target wall and then upwards through the staggered tubes of a slag screen, where the remaining droplets of molten ash are trapped. About 8 per cent. of the ash passes through the slag screen as microscopic dust and is collected in the air heater passes and in a Sturtevant electrostatic precipitator. On test the dust burden of the exit flue gas was 0·033 grains per cub. ft. or less than 10 per cent. of the expected minimum.

An interesting constructional feature is that the front wall enclosing the Cyclone throat, as well as the Cyclone itself, were prefabricated and erected as single units—possibly the first instance in this country of this increasingly popular method of construction. Fig. 4 shows the Cyclone as it is to be seen from the firing floor.

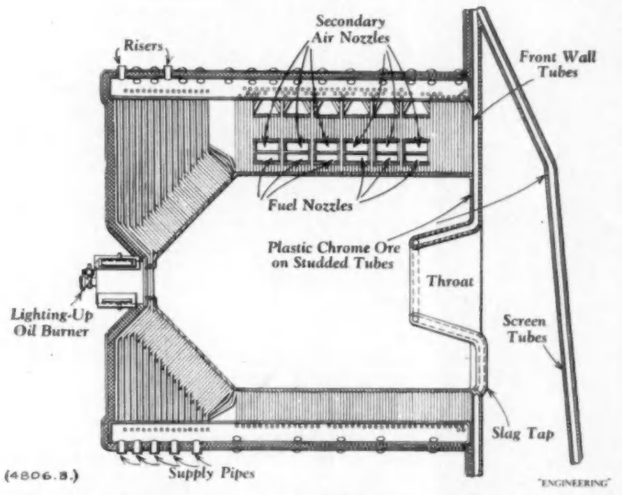


Fig. 2 Cyclone furnace, longitudinal section.

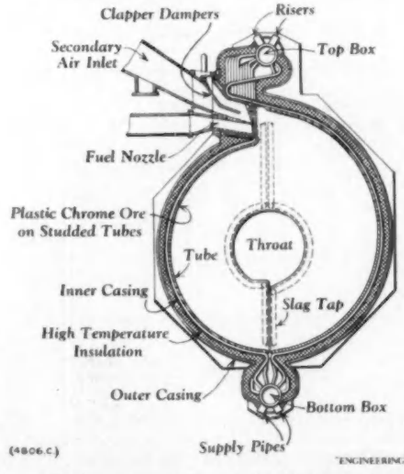


Fig. 3 Cross-section through fuel nozzle.

STEAM RAISING PLANT

The boiler proper is of the Babcock and Wilcox radiant type with natural circulation. Expansion is downwards from the steam drum level, the unit being slung from the overhead steelwork. The Cyclone furnace, secondary furnace and open pass are cooled by water tubes, which are in circuit with the boiler circulation and are clothed with refractory where necessary. The primary and secondary superheaters are of the horizontal and pendant type with two tubular attemperators between them to regulate the steam temperature. One low and one high temperature economiser have been installed as well as a tubular type air heater. The superheaters, economisers and air heaters are also all of Babcock and Wilcox manufacture.

The main and auxiliary fans, which were manufactured by Davidson and Company, Limited, Belfast, are driven by Mather and Platt 3·3 kV direct-on-start motors and controlled by Metropolitan-Vickers oil circuit-breakers. The forced draught fan is of interest since it generates 40 in. water gauge at the inlet to the air heater.

Fig. 4 The Cyclone from the firing floor.

BOILER CONTROL ARRANGEMENTS

The boiler is provided with fully automatic control equipment, supplied by George Kent, Limited, Luton. In this system the fuel/air ratio is initially obtained by the total air flow and fuel controllers being set by the main impulse from the master pressure controller, while the final control is effected by measuring the excess oxygen in the flue gas. The flue gas is automatically and continuously analysed, the analyser putting out a signal proportional to the oxygen content of the gas. The feeder speeds are controlled by a main impulse from the master pressure controller, which is biassed by the oxygen controller signal and finally corrected by a closed loop impulse from the total fuel transmitter, the latter being proportional to the summation of the speeds of all the operating feeders. The total fuel transmitter impulse is fed into the total fuel controller, where it is continuously compared with the combined pressure controller and oxygen analyser signals. Dual air compressors are installed, and should these fail all the controls are locked in their instantaneous position until they are taken over by the manually operated hydraulic controls. The control panel, which was designed by Imperial Chemical Industries, Limited, is of the flow type with full sized instruments inserted into a coloured diagram. Although this takes up more than the normal panel space it has been justified by operational experience.

ELECTRICAL EQUIPMENT

The boiler supplies steam to a 6·5 MW, 6·6 kV back pressure turbo-alternator of Metropolitan-Vickers manufacture. After expansion through 12 single impulse stages the turbine exhausts at a pressure of 235 lb. per sq. in. and thus acts as a "topping set" to the existing 225 lb. per sq. in. range. As a result the total capacity of the station is 28·5 MW.

The turbo-generator is fitted with automatic load and back pressure controls. It can be operated independently with these controls disconnected; in parallel with a substantially constant frequency system with the controls connected or disconnected; or in parallel with other sets, either the load or back pressure being maintained by the corresponding controls.

Continuing **Design**

GETTING MORE OUT OF ALTERNATORS

Rotor and Stator Direct Cooled with Hydrogen

With their budget limited, the C.E.A. are anxious to get the maximum efficiency from their alternators. So the machines they now install are very large—the economic case for large turbo-alternators having been well established. But transport limitations have fixed the maximum weight of alternator components. Stator weights of 100 MW machines designed on conventional lines are about the limit; to increase the output still further a new technique is called for.

The English Electric Company, Limited, have a design that they expect to be suitable for outputs of at least 300 MW. At present they are testing a machine rated at 120 MW. Their innovation has been to use the principle of direct cooling of the conductors in both stator and rotor, pumping hydrogen through them. The rotor of the machine under test has only 60 per cent. of the weight of a conventional rotor. The corresponding figure for the stator is 85 per cent. Greater savings are to be expected in larger designs.

At a recent symposium held at the Siemens Works, Stafford, where the machine has been developed, Mr. V. J. Vickers, chief designer, turbo-alternator section, machine design department, outlined the design problems involved. He pointed out that just after the war several developments could be expected which would give small increases in ratings but none was sufficient to give the large increase required. It was quite obvious that some fundamental change was required.

No substantial increase could be achieved in the magnetic circuit of the machine—for many years the available magnetic materials have been worked to their limit. It remained, therefore, to achieve the uprating by raising the current loading in the stator and rotor windings. This produces a variety of problems and the biggest of these is undoubtedly that of removing the heat from the winding. Direct cooling is the solution adopted: by circulating the coolant in actual contact with the copper, the thermal barrier of the insulation around the coils is eliminated and the heat removal made more efficient.

The machine under test is to be installed at Willington "A" power station, between Burton and Derby. There its rating will be 110 MVA at a power factor of 0·9. Thus it will be somewhat under-run—its normal rating is 150 MVA at 0·8 power factor. The output is at 13·8 kV. One effect of the higher current loadings made possible in this type of alternator is an increase in the armature reaction. To compensate for this the air gap is increased to between 4 and 5 in. The reactance of this class of machine is about 16 per cent., compared with the 10 per cent. of a conventional machine; so that the duty of the switchgear associated with the machine is increased less than in proportion to the increase of machine rating. A disadvantage is that the high leakage flux gives high stray-load losses, which can produce local overheating. To investigate the true effect of these losses, some 300 thermocouples are distributed throughout the machine at present on test.

English Electric use hydrogen as the coolant. It circulates not only through the conductors of the stator and rotor but also through the stator core. Yet liquids, notably water, are much better media for heat transfer. And at first sight liquid is the obvious choice for coolant. Water has been used with success to cool stator windings—Metropolitan-Vickers Electrical Company, Limited, have produced a 30 MW machine with a water-cooled stator. However, whereas the application of water to the stator coils is quite practicable, its application to the stator core or the rotor winding—the most highly rated part of the machine—is not. The problems raised are formidable, and, as yet, these components have to be cooled by hydrogen. The present trend is towards the use of higher hydrogen pressures.

Since two hydrogen circuits are to be present, it makes for simplicity if the third, the stator windings, is cooled by hydrogen too. Other considerations govern this choice and the company put forward the following argument. Owing to the high voltage of the windings, it is impracticable to provide openings in the stator coils for the inlet and exit of the coolant except at the ends; so the coolant flow path must extend over at least the full length of a coil side or of a number of coil sides in series. To use liquid cooling, the ducts must be robust enough to make sure that leakage cannot develop. This means that some, or all, of the individual

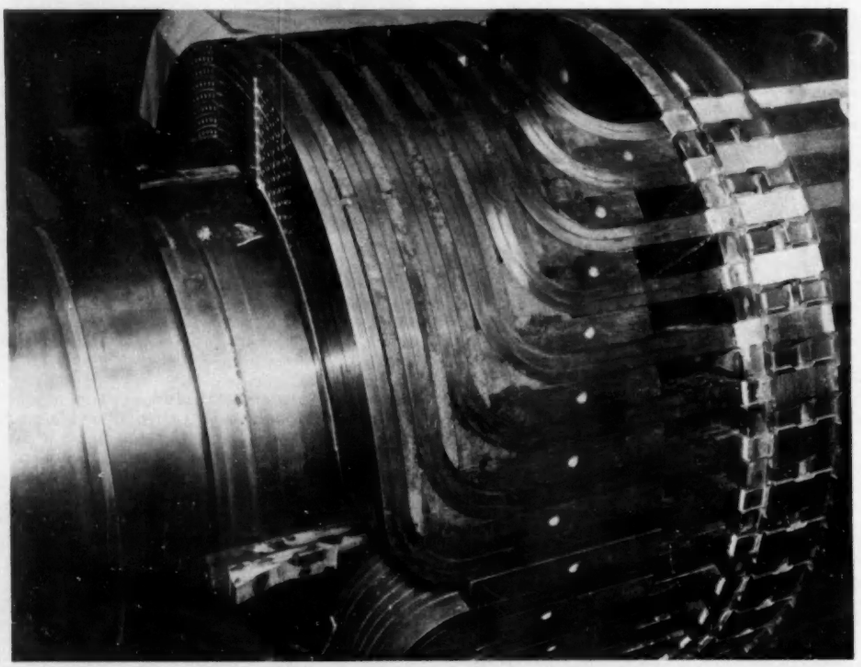


Fig. 1 Hydrogen enters the rotor through the rectangular ports in the side walls of the conductors. The cooling action of the gas enables the size of the rotor to be reduced by 40 per cent.

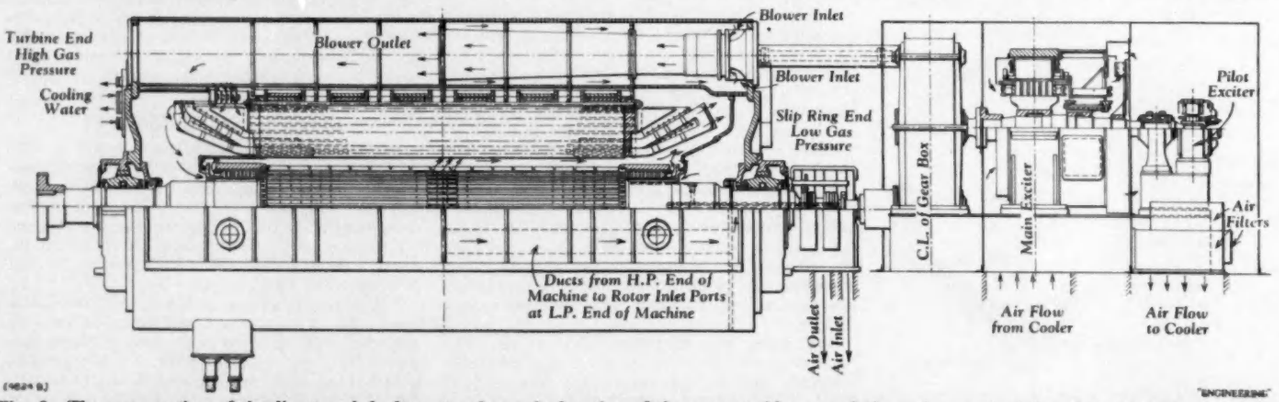


Fig. 2 The cross-section of the direct-cooled alternator shows the location of the separate blower and the various paths followed by the hydrogen. The flow is axially through the stator core and through the stator windings. The flow through the rotor windings is axial but split into several parallel paths.

laminations going to make up the conductors have to be tubular in form. Also, as the eddy current loss in a lamination is proportional to the fourth power of the depth, the tubular lamination must be kept very small if such losses are to be held down to a reasonable value. Very small sizes bring the risk of duct blockage. And there are manufacturing problems both in the production of the tubes themselves and in their brazing to form connections from coil to coil.

If gas is used, ducts can be formed from thin-walled material because there is no problem of leakage. Hence they can be made of relatively large area and independent of the current-carrying strands. The pressure drop along such a coil side can readily be made equal to that required by the rotor and by the stator core, if the latter is also cooled by axial rather than by the more usual radial ducts. Thus, the company claim that an overall ventilation system can be achieved that is very efficient in terms of both cooling and pumping power loss. In particular only about a quarter of the rate of gas circulation around the machine as a whole is required compared with a conventional alternator of the same rating.

Some reduction in overall core diameter and weight could be achieved by the use of a liquid coolant in the stator coils only, because the lower heat capacity of hydrogen means that the space factor of a gas-cooled coil is lower than that of a liquid-cooled one. But the company have found the completely gas-cooled design quite suitable for outputs up to at least 300 MW.

A separate blower unit circulates the hydrogen. As will be seen in Fig. 2, it is mounted in the upper part of the stator frame and driven from the exciter gearbox. Machines with outputs up to about 150 MW can be designed so that the self-fanning action of the rotor, supplemented by shaft-mounted axial-flow fans, provides adequate ventilation. For larger outputs a higher ventilating pressure is needed, and the limitations of the shaft-mounted fan require a more effective form of blower to be used. The higher pressure system has been used in Willington No. 2, which has been built as a prototype to gain experience with this design of machine. Coolers are situated either side of the blower.

Although the rate of gas circulation is low, the basic pressure of 30 lb. per sq. in. and upwards, together with the high differential required, results in a pumping power that is a significant part of the total machine losses. By mounting the blower as a separate unit the designer is free to choose the speed and number of stages necessary for maximum efficiency. The present blower reaches an efficiency between 80 and 85 per cent.

The effect of direct cooling is shown in Fig. 4. The graph shows the variation of current-carrying capacity with hydrogen pressure for a given temperature rise. Direct-cooled conductors are compared with conventionally cooled ones. The curves emphasise the increase in rating made possible by direct cooling: the rating continues to increase usefully with hydrogen pressure up to quite high values, whereas with conventional designs very little improvement is obtained above 30 lb. per sq. in. g. As a natural consequence of this, direct-cooled machines are more sensitive to reductions in coolant pressure. In a direct-cooled machine, designed, say, to take advantage of the enhanced cooling at 30 lb. per sq. in. g., the output is reduced to about 50 per cent. if the gas pressure is lowered to 15 lb. per sq. in. g. This is to be compared with a drop to about 85 per cent. for a conventional machine. In air the latter would carry about half its rated load, but the direct-cooled alternator would not give any useful output, mainly because of stator core loss, which is almost independent of load.

The construction of the rotor windings can be seen from Fig. 5. There are relatively few turns and excitation currents up to about 3,000 amperes may be used; nevertheless, the excitation current is kept below 600 volts. Jointing of adjacent tubes is carried out by brazing, using a resistance brazing technique. Brazes are tested ultrasonically at a frequency of 6 M/cs. Resin-bonded asbestos is used as an insulator between the conductors.

The cooling of the stator is not so direct. As will be seen from Fig. 5, the current-carrying conductors of the stator do not carry gas but are placed adjacent to tubes that do. Glass-braided copper strips make up the main conductors and they are transposed by the Roebel method, as is usual in all heavy current stator windings, to minimise the eddy current losses. The gas tubes are of phosphor bronze 0·011 in. thick. To bend the tubes it is necessary to fill them with low melting point alloy and bends of 4 in. radius are required on tubes 28 ft. long. At the coil-to-coil joints, which are brazed, the tubes extend straight out from the evolute, adequate insulation being provided by moulding of resin-bonded glass fabric. The construction can be seen in Fig. 3.

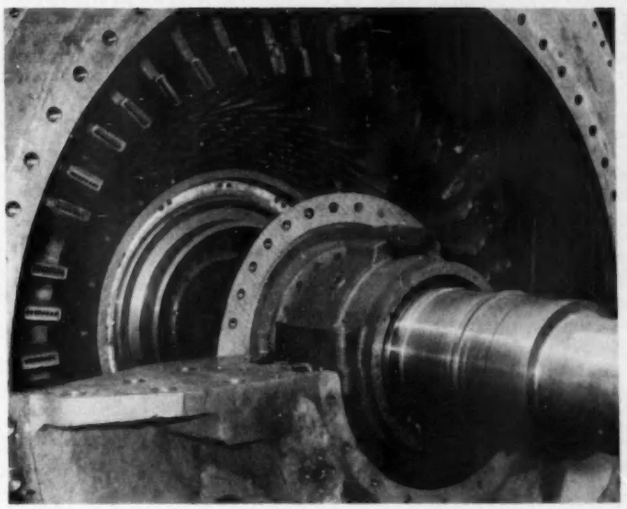


Fig. 3 The end view of the stator shows the inlets to the phosphor-bronze tubes that cool the stator windings.

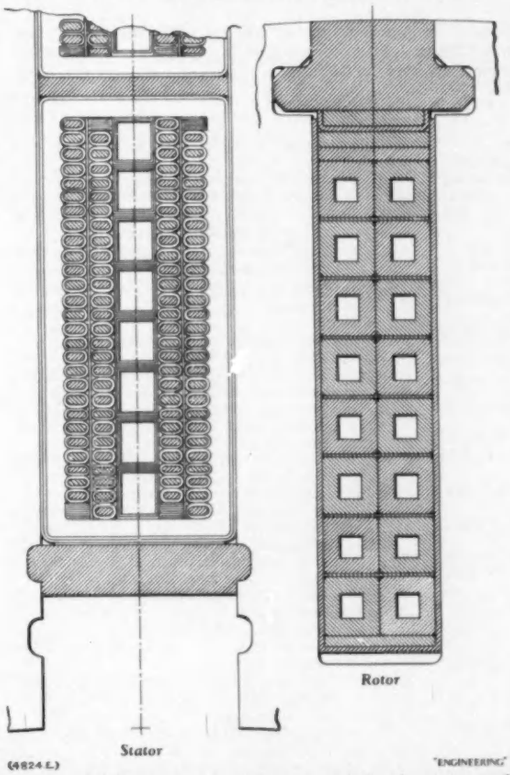


Fig. 5 Different constructions are used for the stator and the rotor windings. By constructing the stator winding from glass-braided copper strip, the eddy current losses are reduced.

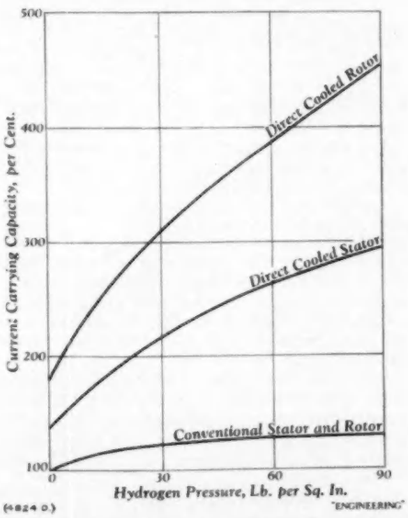


Fig. 4 The variation of current-carrying capacity for a given temperature rise is shown so that the performance of direct-cooled and conventional constructions may be compared.

To cool the rotor the gas enters through two sets of rectangular ports set in the side walls of the rotor conductors. The ports can be seen in the lower right of Fig. 1. The tubes are blocked between the two ports so that the gas is forced to flow in two directions. Part of the gas goes towards the centre of the axial length of the rotor, the other part goes towards the end of the winding. As can be seen in the sectional drawing, Fig. 2, a series of radial holes at the centre of the axial length of the rotor exhaust the hydrogen into the gap where it is swept along to the exhaust end (gearbox end) of the machine. The gas in the end windings comes axially out of ports in the side walls and is deflected along the air gap. The main input of hydrogen from the blower and cooler is to the end remote from the gearbox where the gas enters the stator core and windings and one end of the rotor. Part of the cool gas is diverted to enter the slip-ring end of the rotor. The maximum temperature rise in the conductors is 90 deg. C. above the cool gas temperature.

By ventilating the slot and end windings of the rotor winding in parallel paths, the pressure head needed, and therefore the ventilating power, is minimised. By comparison, end-to-end ventilation, involving say twice the path length, would require twice the gas flow to maintain the

Continuing Design

same copper temperature rise for the same heat input, and would demand, therefore, 16 times the ventilating power.

It is the common experience that if relative movement of conductors occurs due to thermal expansion, this movement is in the end windings, not near the middle of the body. By locating the end winding ports in the side walls, the company has avoided any possibility of the ports becoming blocked by this relative movement. This risk does not arise with the radial exhaust ports at the middle of the body length.

The flow through the stator is more simple. The gas enters each half coil at one end of the machine and leaves at the other. The system gives a reasonable pressure drop and reduces to a minimum the differential thermal expansion between the two coil sides in a slot and between the coils and the core. At normal load the blower operates at 6,900 r.p.m. The output terminals are also hydrogen cooled.

FREE-PISTON GAS GENERATORS

A Discussion of some Fundamentals of Free-piston Gas Generators, including the Calculation of the Design and Part-load Performances and of Design Dimensions.

By J. R. Singham, B.SC.(ENG.), PH.D., A.M.I.MECH.E.*

The system whereby a free-piston gas generator can be used to supply hot gases under pressure to an expansion turbine which delivers shaft work is well known[1] and many practical applications have been described. The mechanical features and applications of the S.I.G.M.A. and Muntz designs are described in a paper by Beale and Watson.[2] The present object is to summarise certain theoretical aspects of the free-piston gas generator. In the first section, the calculation of performance in terms of the main design variable, compressor pressure ratio, is discussed. The presentation is similar to that used by London[3] but various approximations have been made for simplicity. Also an isothermal, rather than an adiabatic, efficiency is used to describe the compressor performance. The second section describes the procedure for estimating the main dimensions of a gas generator of specified power output. The next section outlines the principles by which the power output of an existing design can be modified by scaling the design up or down or altering the piston bulk density. Finally, the procedure for calculating performance at conditions away from the design point, as, for example, at part load, is discussed.

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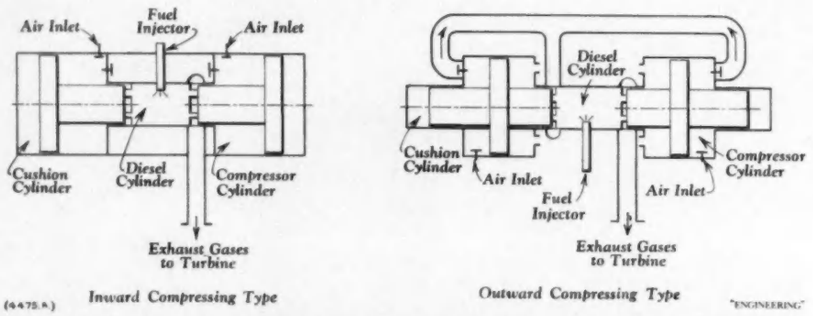

Fig. 1 Basic gas generator layouts. Inward compressing type on left, outward compressing type on right. In both cases the oscillation of two opposed, mechanically free, pistons produces pressurised hot gas for delivery to a turbine.

SYMBOLS

m_a = compressor air delivery, lb. per sec.
m_f = fuel supply to Diesel cylinder, lb. per sec.
m_d = air present in Diesel engine cylinder during combustion, lb. per sec.
P_{ex} = gas generator exhaust pressure, lb. per sq. in. abs.
P_a = atmospheric pressure, lb. per sq. in. abs.
t_{ex} = gas generator exhaust temperature, deg. C.
t_a = atmospheric temperature, deg. C.
T_{ex} = gas generator exhaust temperature, deg. C. absolute.
T_a = atmospheric temperature, deg. C. absolute.
r = compressor pressure ratio. = cylinder pressure during delivery / cylinder pressure during suction
r_d = Diesel cylinder volumetric compression ratio.
W'_g = work from frictionless adiabatic expansion of exhaust gases from P_{ex} down to P_a, ft.-lb. per sec.
W_c = compressor cylinder indicated work, ft.-lb. per sec.
W_d = Diesel cylinder indicated work, ft.-lb. per sec.
H_f = lower calorific value of fuel, C.H.U. per lb.
Q_w = heat rejected to cooling water, C.H.U. per sec.
η_d = indicated thermal efficiency of Diesel section = $\dfrac{W_d}{m_f J H_f}$.
η_m = efficiency factor allowing for piston friction losses and losses in cushion cylinder = $\dfrac{W_c}{W_d}$
η_w = fraction of fuel energy retained in gas stream.
η_t = turbine adiabatic expansion efficiency.
η_g = gas generator thermal efficiency = $\dfrac{W'_g}{m_f J H_f}$.
η_{or} = plant overall thermal efficiency = $\eta_g \times \eta_t$.
η_{vol} = volumetric efficiency of compressor cylinders.
η_{ch} = charging efficiency of Diesel cylinder. = $\dfrac{\text{volume of compressed air trapped}}{\text{swept volume}}$.
η_c = isothermal efficiency of compressor.
k_1 = factor (less than unity) taking account of valve and port pressure losses.
$k_2 = \dfrac{\eta_w}{\eta_m \eta_c \eta_d} \times \dfrac{\gamma - 1}{\gamma}$.
S = stroke, ft.
D_c = compressor piston diameter, ft.
D_d = Diesel cylinder diameter, ft.
x = distance travelled by piston from rest, ft.
V_c = compressor clearance volume, cub. ft.
V_s = compressor swept volume, cub. ft.
V_d = Diesel cylinder clearance volume, cub. ft. per cylinder.
V_{sd} = effective swept volume of each Diesel piston, cub. ft.
U_p = mean piston velocity, ft. per sec.
U = instantaneous piston velocity, ft. per sec.
N = frequency of oscillation, cycles per sec.
M = piston mass, lb.
F_x = net force acting on piston at any instant, lb.
t = duration of piston stroke, sec.
ρ_a = density of atmospheric air, lb. per cub. ft.
ρ_d = Diesel cylinder charge density, lb. per cub. ft.
ρ_p = piston block density, lb. per cub. ft.
n = index of expansion for compressor clearance volume air.
C_p = mean specific heat at constant pressure of exhaust gases between t_{ex} and t_a, C.H.U. per lb. per deg. C.
γ = ratio of specific heats of exhaust gas, mean value between t_{ex} and t_a.
R = gas constant, 96 ft.-lb. per lb. deg. C.
J = mechanical equivalent of heat, 1,400 ft.-lb. per C.H.U.
g = 32·2.

The free-piston gas generator is a reciprocating engine that runs on atmospheric air and liquid fuel and delivers a supply of hot exhaust gas under pressure. The engine includes two reciprocating pistons, a central Diesel cylinder and two compressor pistons. There is no crankshaft and no shaft power is delivered by the gas generator, but the two pistons are mechanically coupled by a light mechanism to ensure synchronisation. The two basic layouts are shown diagrammatically in Fig. 1. The inward compressing type results in a short, compact layout with no external air ducts, but the work loss is rather high since the cushion cylinder has to store all the Diesel expansion work. With the outward compressing layout the work loss is reduced but the design becomes more elaborate. Most of the following discussion applies to either layout, but occasionally only the inward compressing type is considered.

PERFORMANCE AS A FUNCTION OF COMPRESSOR PRESSURE RATIO

Among the quantities used to describe the performance of a free-piston gas generator are:

(*a*) air : fuel ratio, $\dfrac{m_a}{m_f}$;

(*b*) gas generator exhaust or delivery pressure, P_{ex};

(*c*) gas generator exhaust or delivery temperature, t_{ex};

(*d*) specific power output, $\dfrac{W'_g}{550\ m_a}$;

(*e*) thermal efficiency, $\dfrac{W'_g}{m_f H_f}$.

All these quantities can be calculated from the compressor pressure ratio r and the indicated thermal efficiency of the Diesel engine section, η_d, regarding r and η_d as independent variables, and assuming reasonable values for such empirical factors as compressor efficiency, mechanical efficiency, etc. The Diesel cylinder compression ratio r_d may be used in place of η_d; η_d may then be regarded as defined by the relation

$$\eta_d = 1 - \left(\frac{1}{r_d}\right)^n$$

where n is an empirical exponent for high-compression Diesel engines. The compressor pressure ratio r has a greater influence on performance than the Diesel thermal efficiency η_d as will be evident from the graphs presented below.

Overall air : fuel ratio.—The air : fuel ratio referred to here is the ratio of the air delivered by the compressor to the fuel supplied to the Diesel cylinder, i.e., the overall air : fuel ratio. Some of the air delivered by the compressor is used for scavenging and a further part of it could be allowed to by-pass the Diesel cylinder. The air : fuel ratio during combustion or Diesel air : fuel ratio is therefore smaller than the overall air : fuel ratio. The overall air : fuel ratio is readily obtained by equating the compressor work W_c to the Diesel work W_d multiplied by an efficiency factor η_m, which takes account of piston friction and losses in the cushion cylinder,

$$W_c = \eta_m\ W_d.$$

If η_c is the isothermal efficiency of the compressor then

$$W_c = \frac{m_a R T_a}{\eta_c} \log_e r.$$

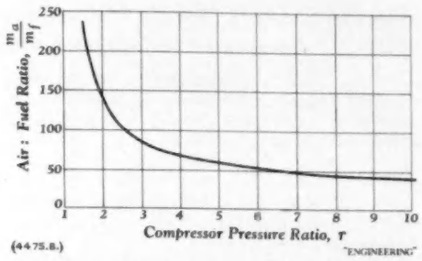

Fig. 2 The ratio of air compressed to fuel supplied is largely determined by the compressor pressure ratio and hence by the gas generator exhaust or delivery pressure.

Also, from the definition of η_d,

$$W_d = \eta_d m_f J H_f.$$

Combining these three equations, we have

$$\frac{m_a}{m_f} = \frac{\eta_m \eta_c \eta_d J H_f}{R T_a \log_e r}, \quad . \quad . \quad (1)$$

giving the overall air : fuel ratio as a function of compressor pressure ratio. The equation reduces to $\frac{m_a}{m_f} = \frac{93{\cdot}2}{\log_e r}$ for the following numerical values: $\eta_m = 0{\cdot}85$, $\eta_c = 0{\cdot}60$, $\eta_d = 0{\cdot}35$, J = 1,400 ft.-lb. per C H U., H_f = 10,300 C H U. per lb., R = 96 ft.-lb. per lb. per deg. C., $T_a = 288$ deg. K. The variation of air : fuel ratio with compressor pressure ratio is shown graphically in Fig. 2. Since η_m, η_c and η_d occur as a product in equation (1), the graph applies whenever the product $\eta_m \eta_c \eta_d$ has the value $0{\cdot}85 \times 0{\cdot}60 \times 0{\cdot}35$ or about 0·18, regardless of the individual efficiencies.

Diesel Cylinder Air : Fuel Ratio.—The ratio of total air compressed to air trapped in the Diesel cylinder, $\frac{m_a}{m_d}$, does not enter into these performance calculations and can be selected arbitrarily, subject only to the requirements for good scavenging and combustion. The Diesel cylinder air : fuel ratio $\frac{m_d}{m_f}$ is related to the overall air : fuel ratio by the equation:

$$\frac{m_d}{m_f} = \frac{m_a}{m_f} \frac{m_d}{m_a},$$

where $\frac{m_a}{m_f}$ can be determined from equation (1). $\frac{m_d}{m_f}$ can be independently varied by varying $\frac{m_d}{m_a}$.

Gas Generator Exhaust Pressure.—The gas generator exhaust or delivery pressure is mainly determined by the compressor pressure ratio and the pressure losses through the various valves and ports. If these losses were negligible P_{ex} would be equal to $r P_a$. To take account of the losses a factor, k_1, less than unity, is introduced:

$$P_{ex} = k_1 r P_a. \quad . \quad . \quad (2)$$

Figs. 2, 4, 5 and 6 have been drawn to a base of compressor ratio r, but they can equally be regarded as having the base $\frac{1}{k_1} \frac{P_g}{P_a}$.

Gas Generator Exhaust Temperature.—Viewed externally, the free-piston gas generator is simply a machine for converting air drawn from the atmosphere into a stream of hot gas under pressure; the machine is supplied with fuel of known calorific value and rejects heat to a supply of cooling water (see Fig. 3). Applying the steady flow energy equation to this machine and regarding the air as a perfect gas,

$$m_f H_f - Q_w = m_a C_p (t_{ex} - t_a).$$

For simplicity, the rate of exhaust gas flow is taken as equal to the rate of air consumption, and complete combustion is assumed.

If Q_w is low, then a high proportion of the fuel energy is transferred to the gas stream. Denoting this proportion as an efficiency η_w,

$$m_a C_p (t_{ex} - t_a) = \eta_w m_f H_f.$$

If, for example, the heat transferred to the cooling water is equivalent to 20 per cent. of the heating value of the fuel, then η_w is 80 per cent.

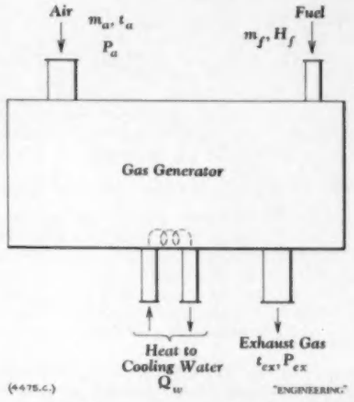

Fig. 3 The gas generator can be regarded as a machine running on air and fuel and delivering pressurised hot gas instead of shaft power.

The last equation can be written:

$$t_{ex} - t_a = \frac{m_f \eta_w H_f}{m_a C_p},$$

showing that the temperature rise is inversely proportional to the air : fuel ratio. The expression for the air : fuel ratio given in equation (1) may now be substituted for $\frac{m_f}{m_a}$, giving:

$$t_{ex} - t_a = \frac{\eta_w}{\eta_m \eta_c \eta_d} \frac{R}{J C_p} T_a \log_e r.$$

But $\frac{R}{J C_p} = \frac{\gamma - 1}{\gamma}$; hence the temperature rise is given by:

$$t_{ex} - t_a = k_2 T_a \log_e r, \quad . \quad (3)$$

where

$$k_2 = \frac{\eta_w}{\eta_m \eta_c \eta_d} \frac{\gamma - 1}{\gamma}.$$

Equation (3) shows that the exhaust temperature is not an independent variable, but is determined by the compressor pressure ratio, r; and since the exhaust pressure is related to r by equation (2), it is evident that the exhaust temperature is largely determined by the exhaust pressure. In other words, engines operating at equal exhaust pressures will, to a first approximation, have equal exhaust temperatures, regardless of other design differences. The relation between exhaust temperature and compressor pressure ratio is shown graphically in Fig. 4 for the following numerical values: $t_a = 15$ deg. C., $\eta_w = 0{\cdot}80$, $\eta_m = 0{\cdot}85$, $\eta_c = 0{\cdot}60$, $\eta_d = 0{\cdot}35$, $\frac{\gamma - 1}{\gamma} = 0{\cdot}27$. The corresponding value of k_2 is 1·21 and the curve therefore applies when k_2 has this value regardless of the values of the individual factors.

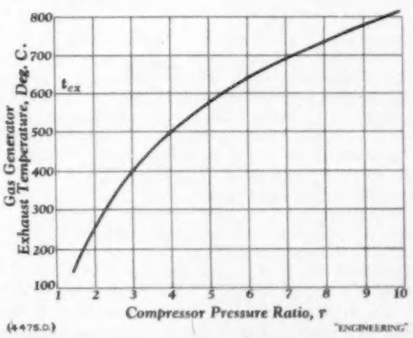

Fig. 4 The exhaust or delivery temperature depends on the pressure ratio and they cannot be varied independently of each other.

Specific Power Output.—The shaft work, W'_g, that could be obtained in a frictionless adiabatic expansion of the gas generator exhaust gases through a turbine from P_{ex} down to P_a is given by:

$$W'_g = m_a J C_p T_{ex} \left[1 - \left(\frac{P_a}{P_{ex}}\right)^{\frac{\gamma-1}{\gamma}}\right]. \quad (4)$$

The gas generator specific power output, expressed in horse-power per lb. of air per sec., is therefore given by:

specific power output

$$= \frac{W'_g}{550\, m_a} = \frac{J C_p}{550} T_{ex} \left[1 - \left(\frac{P_a}{P_{ex}}\right)^{\frac{\gamma-1}{\gamma}}\right].$$

From equation (3),

$$T_{ex} = T_a (1 + k_2 \log_e r), \quad . \quad (5)$$

and from equation (2), $\frac{P_{ex}}{P_a}$ is equal to $k_1 r$. Hence we have:

specific power output

$$= \frac{J C_p}{550} T_a (1 + k_2 \log_e r) \left[1 - \left(\frac{1}{k_1 r}\right)^{\frac{\gamma-1}{\gamma}}\right]$$

h.p. per lb. air per sec.

In Fig. 5, specific power output is shown plotted against compressor pressure ratio, for numerical values as follows: $k_2 = 1{\cdot}21$ (corresponding, as in the case of exhaust temperature above to $\eta_w = 0{\cdot}80$, $\eta_m = 0{\cdot}85$, $\eta_c = 0{\cdot}60$, $\eta_d = 0{\cdot}35$ and $\frac{\gamma - 1}{\gamma} = 0{\cdot}27$), $t_a = 15$ deg. C., $C_p = 0{\cdot}254$, $\frac{\gamma - 1}{\gamma} = 0{\cdot}27$ and $k_1 = 0{\cdot}7$.

If the gas generator exhausts to a turbine of adiabatic efficiency, η_t, then the turbine specific power output is obtained by multiplying the gas generator specific power output by η_t. This curve is also shown in Fig. 5 for $\eta_t = 0{\cdot}80$.

As the power output is proportional to the turbine inlet temperature, it is clear that the power output can be increased by burning additional fuel in the gas generator exhaust gases.

Thermal Efficiency.—The thermal efficiency of the gas generator, η_g, is conveniently defined as the ratio of the ideal shaft work W'_g (defined in the previous section) to the heat that could be derived from complete combustion of the fuel at constant pressure:

$$\eta_g = \frac{W'_g}{m_f J H_f}.$$

Equations (1), (2), (4) and (5) enable this to be written:

$$\eta_g = \eta_w \left(1 + \frac{1}{k_2 \log_e r}\right) \left[1 - \left(\frac{1}{k_1 r}\right)^{\frac{\gamma-1}{\gamma}}\right]. \quad (6)$$

The thermal efficiency is thus a fairly simple function of the compressor pressure ratio. The expression may be regarded as the equivalent for a free-piston gas generator of the empirical expression used for the thermal efficiency of petrol and Diesel engines:

$$\eta = 1 - \left(\frac{1}{R_c}\right)^n$$

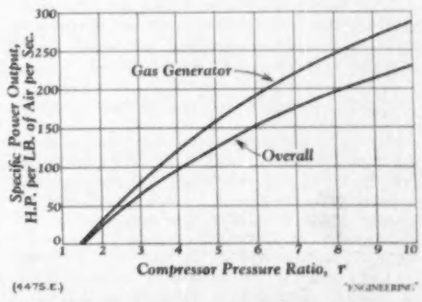

Fig. 5 The upper curve shows the specific power output for frictionless adiabatic expansion while the lower curve corresponds to a turbine efficiency of 80 per cent.

Continuing Design

where R_e is the engine compression ratio and n is an empirical constant. η_w and k_1 in equation (6) are empirical constants depending on the engine design. k_2, however, contains η_d, the efficiency of the Diesel section. Therefore η_g depends to some extent on the value of η_d, but as η_d would not be expected to vary widely, the main variable in equation (6) is the pressure ratio r.

Fig. 6 shows the variation of gas generator thermal efficiency with compressor pressure ratio for three values of η_d. The other numerical quantities have the values used above in calculating the specific power output. It is evident that good thermal efficiency requires a pressure ratio of 3 : 1 or more. However, η_g is not particularly sensitive to variation in η_d; for instance, at a pressure ratio of 5 : 1, a decrease in η_d from 0·45 to 0·35 only reduces η_g from 0·38 to 0·35.

To obtain the overall plant efficiency, η_{ov}, when the gas generator exhaust gases are expanded through a turbine of adiabatic efficiency η_t, it is simply necessary to multiply η_g by η_t

$$\eta_{ov} = \eta_g \, \eta_t.$$

The curves showing the variation of η_{ov} with r in Fig. 6 are for a turbine efficiency of 80 per cent.

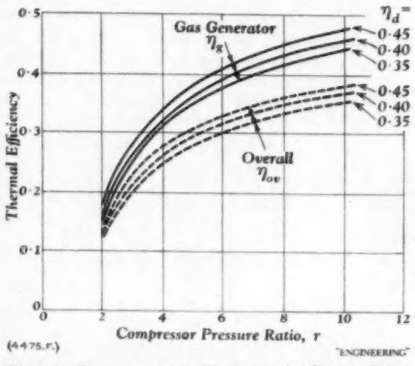

Fig. 6 Pressure ratio is the main factor determining the thermal efficiency of the gas generator and of the whole plant. The efficiency of the Diesel engine section has an appreciable but secondary effect.

DESIGN PROCEDURE

A gas generator is designed to feed a gas turbine the power output of which is specified. The procedure to be followed in arriving at an estimate of suitable design dimensions is as follows:

(1) *Fix Compressor Pressure Ratio, r.*—From the preceding section it is clear that the main variable to be decided upon is the compressor pressure ratio, r. This will be made as high as possible in order to ensure high efficiency and specific power output. r is limited by the increasing number of turbine stages required to maintain good turbine efficiency at high expansion pressure ratios. For automotive application, a single-stage radial flow turbine would lead to design simplicity, but r could hardly be made greater than 4·0.

(2) *Fix Diesel Cylinder Compression Ratio, r_d.*—Although the Diesel section thermal efficiency, η_d, increases as r_d is increased, it has been seen that the overall plant efficiency, η_{ov}, is not particularly sensitive to η_d and therefore to r_d. As the Diesel cylinder is considerably supercharged, a moderate value of r_d will be selected, so as to avoid excessive compression pressure. η_d can now be estimated.

(3) *Required Air Flow.*—Having fixed the compressor pressure ratio and the Diesel compression ratio, the specific power output of the plant can be estimated in the manner outlined in the preceding section. The required power output was specified from the outset and the required air flow can now be calculated.

(4) *Overall Plant Efficiency, η_{ov}.*—Although not required in estimating design dimensions, η_{ov} can be calculated at this point from the values of r and η_d.

(5) *Compressor Piston Diameter, D_c.*—Considering the swept volume of the compressor pistons, the piston diameter is related to the required air flow, m_a, by the equation:

$$2 \, \rho_a \frac{\pi}{4} D_c^2 \frac{U_p}{2} \eta_{vol} = m_a,$$

where ρ_a is the atmospheric density, U_p is the mean piston velocity and η_{vol} is the compressor cylinder volumetric efficiency. It is assumed that the outward and inward strokes are of approximately equal duration; the accuracy of this assumption is revealed during stage (13). Reasonable values for U_p and η_{vol} are now assumed and the corresponding value of D_c is calculated. The highest value of U_p consistent with reasonable rates of wear is required, in order that D_c shall be as small as possible. Later stages of the design calculations reveal whether the assumed value of U_p can be realised with reasonable piston dimensions. Also, stage (7) below will reveal whether the assumed value of η_{vol} corresponds to a reasonable compressor clearance volume.

(6) *Stroke, S, and Frequency, N.*—The stroke and frequency of oscillation are related by the equation $U_p = 2 \, S \, N$, where U_p has already been fixed. The stroke and therefore the engine size are kept low by assuming a high value for N. If, however, N is made too large difficulty may arise in the design of the fuel injection equipment; also the stroke may be too small to permit reasonable volumetric efficiency and proper uncovering of the Diesel cylinder ports. Subject to these considerations, any values of S and N giving the assumed value of U_p may be used, only the length and not the performance of the gas generator being affected.

(7) *Compressor Clearance Volume, V_c.*—This is of course related to the volumetric efficiency:

$$\eta_{vol} = 1 - \frac{V_c}{V_s}(r^n - 1),$$

where V_s is the swept volume, $= \frac{\pi}{4} D_c^2 S$, and n is the index of expansion for the clearance air. Hence the clearance volume, corresponding to the value of η_{vol} assumed earlier, can be calculated. The basic design dimensions of the compressor cylinder are now known, viz., D_c, S and V_c.

(8) *Diesel Cylinder Diameter, D_d.*—A value for the ratio $\left(\frac{\text{total air compressed}}{\text{air present during combustion}}\right)$, $\frac{m_a}{m_d}$, must now be assumed. As stated in the preceding section, $\frac{m_a}{m_d}$ does not enter the cycle calculations and is therefore chosen arbitrarily to satisfy scavenging and combustion requirements. m_d can now be obtained and D_d found from the relation:

$$2 \, \rho_d \frac{\pi}{4} D_d^2 \frac{U_p}{2} \eta_{ch} = m_d,$$

where ρ_d is the Diesel cylinder charge density, and η_{ch} is the Diesel cylinder charging efficiency, defined as the ratio:

$$\frac{\text{(volume of compressed air trapped)}}{\text{(swept volume)}}$$

ρ_d is known from compressor calculations, but it is necessary to estimate the value of η_{ch}.

(9) *The Diesel Cylinder Clearance Volume, V_d.*—This is estimated from the relation:

$$r_d = 1 + \frac{V_{sd}}{V_d},$$

where V_{sd} is the effective swept volume of each Diesel cylinder, and can be calculated from the cylinder diameter and the stroke, making a deduction for that part of the stroke during which the ports are uncovered. The basic design dimensions of the Diesel cylinder, viz., D_d, S and V_d, are now known.

(10) *Compressor and Diesel Cylinder pv-diagrams.*—The pv diagrams for the compressor and Diesel cylinders can now be estimated. The ratio of the compressor diagram area to the Diesel cylinder diagram area must equal η_m. The diagrams are drawn to be consistent with the efficiencies assumed earlier.

(11) *Cushion Cylinder Storage Work.*—If the gas generator is of the inward compressing type, the work to be stored by each cushion cylinder during the outward stroke of the pistons equals the sum of the areas under the Diesel and compressor pv curves during expansion and induction, respectively. For the outward compressing type, the work stored is the difference between the area under the Diesel pv curve during expansion and the area under the compressor pv curve during compression. This work quantity can now be found from the pv diagrams.

(12) *Cushion Cylinder Dimensions and Air Content.*—For the inward compressing type, the cushion cylinder diameter equals the compressor cylinder diameter and the cushion piston stroke is, of course, equal to the compressor stroke. The work stored can be expressed in terms of the cushion cylinder clearance volume and the cushion pressure at the start of cushion compression. Since the work to be stored is now fixed, either quantity can be found once a value is assigned to the other. A small clearance volume leads to wide pressure variation in the cushion cylinder while a large volume leads to a small variation (see Fig. 7). The work stored, and therefore the area under the pressure-stroke curve, is the same in either case. In order to achieve high mean piston speeds and high power output, it is necessary for as much work as possible to be stored and released with the pistons near their outer extreme positions. Clearly then, a small clearance volume leads to high

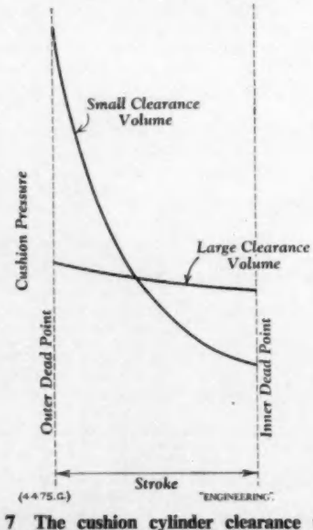

Fig. 7 The cushion cylinder clearance volume affects the magnitude of pressure variation in the cushion cylinder but the amount of work stored is the same in both cases.

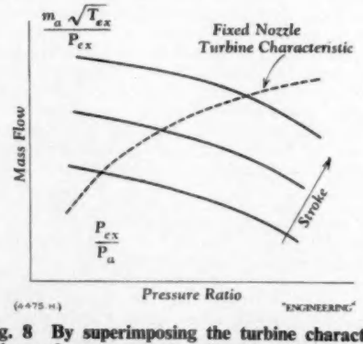

Fig. 8 By superimposing the turbine characteristic on the gas generator characteristics, the gas generator running conditions can be found.

piston speeds. If, however, a very small clearance volume were used, the maximum cushion pressure would be excessive; also heat transfer losses would be high and the pumping loss would be large. The cushion cylinder clearance volume also influences the behaviour of the engine during rapid changes of load, but it is not proposed to discuss this particular aspect. With these considerations in mind, a suitable value for the clearance volume is selected and the pressure-stroke relation is calculated.

(13) *Piston Mass.*—The pressure in all cylinders at any point in the cycle are now known, and a diagram showing the net force, F_x, acting on the piston at any position is readily drawn. The instantaneous piston velocity, U, when the piston has travelled a distance x from the rest is given by:

$$\frac{M U^2}{2g} = \int_0^x F_x \, dx. \quad . \quad . \quad (7)$$

If we assume for the moment that the piston has unit mass, the piston velocity at any position can be calculated. The duration of each stroke can be found from the equation:

$$t = \int_0^x \frac{dx}{U},$$

and the mean piston velocity, U_p', can be calculated. This value must now be compared with the value U_p assumed earlier. The required piston mass to give a mean piston velocity U_p is therefore $\left(\frac{U_p'}{U_p}\right)^2$. The initial design calculation is now complete and the next stage is one of mechanical design.

SCALING A GAS GENERATOR UP OR DOWN

If a proved design for a gas generator of some particular power exists, it may be convenient to obtain the approximate dimensions of a gas generator required to deliver some other power by scaling the known design up or down. The compressor pressure ratio and Diesel cylinder compression ratio do not change, and, theoretically, the performance of the scaled design should be that of the original, i.e., the specific power outputs and thermal efficiencies will be the same if the exhaust pressures are equal. The oscillation speed and power output, however, may be expected to alter. The design power output can also be changed by altering the piston block density, as discussed below. The piston motion is governed by equation (7), from which the effect of dimensional changes can be deduced. Secondary factors, such as the effect of scaling on port pressure losses, are neglected.

(*a*) *Scaling Diameters.*—Suppose all diameters are multiplied by a factor p. The piston mass will be altered by a factor p^3 and the forces acting on the piston will also vary as p^3. It is clear from equation (7) that, as both M and F_x vary as p^3, the piston velocity is not affected. Thus the speed of oscillation N is not affected by scaling all diameters up or down in the same ratio. As the stroke and speed are constant, the mass flow and power output must vary as p^2.

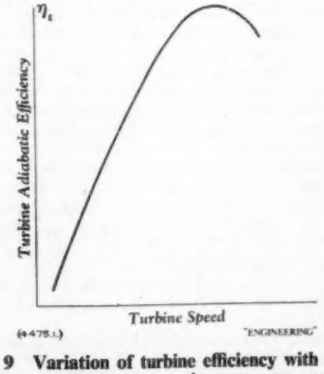

Fig. 9 Variation of turbine efficiency with speed for a particular expansion pressure ratio.

(*b*) *Scaling Axial Dimensions.*—Suppose all axial dimensions are multiplied by a factor q. The piston mass and the length of the piston force/stroke diagram are altered in the same ratio. Thus in equation (7) both M and the right-hand side vary as q and therefore the value of U at any particular fraction of the stroke is unaltered; the length of the piston velocity/stroke diagram is simply altered in the ratio q. Hence the speed of oscillation N varies as $\frac{1}{q}$. But the mass flow and power output are proportional to the product of oscillation speed and stroke and are therefore unaffected by the scaling of axial dimensions. Doubling the axial dimensions of a gas generator merely doubles the stroke and halves the speed of oscillation without altering the power. The mean piston speed also remains constant.

(*c*) *Altering Piston Block Density,* ρ_p.—The block density of the piston, i.e., its mass divided by its block volume, can be varied by altering the internal structure. The effect is to alter the speed of oscillation without affecting the stroke. The work done by the gas forces on the piston up to any point in the stroke is unchanged and therefore the kinetic energy of the piston must be unchanged, i.e., $M U^2$ is constant, M is proportional to ρ_p and therefore U varies as $\frac{1}{\sqrt{\rho_p}}$. Thus speed of oscillation and power output vary as $\frac{1}{\sqrt{\rho_p}}$.

PERFORMANCE OFF DESIGN POINT

If we wish to specify the operating point of a normally aspirated Diesel engine we must specify two variables, torque and speed. The same applies to a petrol engine, unless the carburettor fuel jets and the ignition timing can be independently controlled. For a free-piston gas generator exhausting through a throttle valve or a variable nozzle area turbine, and in which the quantity of cushion air can be independently controlled, there are three independent variables, i.e., three quantities must be specified in order to specify the operating point. If, for example, the cushion pressure at the start of cushion compression is made to equal its design value, and the throttle valve is adjusted until the exhaust pressure has its design value, it remains necessary to adjust some third quantity, the fuel consumption, say, to its design value, in order that all other quantities shall have their design values. If a gas generator exists in reality, then the full performance characteristics in terms of the three variables can be found by direct test. If, however, the design only exists on paper, then it may be desirable to estimate the performance characteristics by calculation. In this case, it is more convenient to regard stroke, Diesel compression ratio and exhaust pressure as the three independent variables. Having specified these three quantities, we may then find all the other quantities, such as speed of oscillation, gas flow, fuel consumption, etc., by calculation. The outline of the procedure for the inward compressing type is as follows:

1. Specify values for stroke, S, and exhaust pressure, P_{ex}.

2. Specify a value for the Diesel cylinder compression ratio r_d. r_d cannot be regarded as completely independent, since at low values of P_{ex}, r_d should be reasonably high to ensure good combustion. On the other hand, at high values of P_{ex}, r_d must be low enough to avoid excessive compression pressure. For this reason, it is desirable to specify r_d as a function of P_{ex}. When this is done, the number of independent variables is reduced to two, viz., S and P_{ex}.

3. Calculate the Diesel cylinder inner dead point from r_d and the effective outer dead point, the latter being fixed by the Diesel port positions. The inner dead point in the compressor cylinder can now be found.

4. The inner and outer dead points in the compressor cylinder are now known and the pressure/stroke diagram can be constructed. (It is necessary to make allowance for valve and port pressure losses, in order to estimate the compressor delivery pressure from P_{ex}.)

5. The inner dead point and the effective outer dead point in the Diesel cylinder are known and the compression line can be drawn on the pressure/stroke diagram. The remainder of the diagram must now be constructed, so that the net area is equal to the area of the compressor pressure/stroke diagram plus an allowance for piston friction and cushion cylinder losses.

6. Calculate the cushion cylinder pressure at the inner dead point required to give work storage corresponding to the sum of the areas under the Diesel and compressor pressure/stroke curves during expansion and induction respectively. (The cushion cylinder dead points are determined from those in the compressor cylinder.) Thus the pressure/stroke diagram for the cushion cylinder can also be found.

7. The three pressure/stroke diagrams have now been found and the net force on the piston at any point in the cycle can be found. Hence the velocity/stroke diagram can be derived and the oscillation speed, N, can be calculated.

8. Calculate the mass flow rate, m_a, from the mass flow per cycle (obtained from the compressor pressure/stroke diagram) and the oscillation speed.

9. Calculate the exhaust temperature, t_{ex}, from the compressor pressure ratio (see equation (3)).

10. Calculate the fuel consumption, m_f, from the fuel used per cycle (obtained from the Diesel cylinder pressure/stroke diagram) and the oscillation speed.

All the main quantities have now been obtained. The process can be repeated for a series of other strokes and exhaust pressures, and graphs can be plotted showing the various quantities as functions of exhaust pressure and stroke. The graph of mass flow should be in non-dimensional form to permit comparison with the turbine mass flow characteristic (see Fig. 8). A lower limit is set to the stroke at any particular exhaust pressure by the need to secure proper uncovering of the Diesel cylinder ports. An upper limit to the stroke at a given exhaust pressure is set by the need to maintain a reasonable clearance in the cushion cylinder and avoid excessive cushion pressure.

The required cushion pressure-stroke relation at any particular stroke and exhaust pressure is known. One possible method of ensuring the correct pressure-stroke relation is by regulating the pressure to its correct value at a single point in the stroke. The Diesel compression ratio will then have the value required at that particular value of P_{ex}. A suitable point to specify is the distance, y, from the inner dead point at which the cushion pressure equals the scavenge pressure. A graph showing the variation of y with S and P_{ex} can now be drawn. If the gas generator exhausts through a fixed nozzle turbine, S is related to P_{ex} by the equality of the gas generator and turbine air flows (see Fig. 8). y is therefore determined by P_{ex} alone and the cushion pressure control must therefore be responsive to P_{ex}. For a variable nozzle turbine, there will be a separate relation between y and P_{ex} for each turbine nozzle angle, and ideally the cushion pressure control should be responsive to both P_{ex} and the turbine nozzle setting.

An alternative method of ensuring the required cushion pressure-stroke relation at any particular running point is to regulate the mean cushion pressure in the way described by Eichelberg.[1] For this method, the variation of mean cushion pressure with P_{ex} and S is required and can be determined readily using the cushion cylinder pressure-stroke diagram. The gas horse-power at any value of P_{ex} can be calculated from the mass flow and the exhaust temperature and pressure. For a particular value of $\frac{P_{ex}}{P_a}$, the turbine efficiency will vary with turbine speed in the manner shown in Fig. 9. The brake horse-power is calculated from the product of gas horse-power and η_t at a particular value of P_{ex}.

The thermal efficiency of the gas generator at

part load is calculated from the compressor pressure ratio, as described earlier in the section on performance. The overall efficiency is obtained as a product of the gas generator and turbine efficiencies. It should be noted that the calculation of brake horse-power and overall thermal efficiency as functions of P_{ex} using the turbine mass flow characteristic can precede the method outlined above for calculating all the part load operating conditions since knowledge of oscillation speed, stroke and cushion pressure is not required at this stage.

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Research and Development

INVESTIGATING FAN NOISE

A new comprehensively-equipped acoustics laboratory for investigating the noise characteristics of large and small fans over their whole operating range has been opened recently at the works of Keith Blackman Limited, Mill Mead-road, Tottenham, London, N.17. The new facility also allows simultaneous physical tests of air delivery, pressure, speed and power to be carried out.

The laboratory comprises two brick buildings, one inside the other, with a 4 to 6 in. air space between. The outer shell is 14 in. brickwork, the inner 9 in. The complete structure rests on a concrete foundation laid on a 2 in. thick cork raft. The roof is also of double construction, both inner and outer sections being formed of pre-cast concrete slabs with a 9 in. air space between. These air spaces are used for ventilation purposes. Supported from the inner walls and ceiling, and leaving a further 3 in. air space, is a timber framework to which is fitted 3 in. thick mineral-wool sound-absorbing slabs which reduce reverberation time to the absolute minimum.

VENTILATION

Entrance to the sound chamber is by double doors which form an airlock. The doors are steel-framed with heavy timber inner frames, and are lined with sound-absorbing pads. The joints between timber, steel and brickwork are sealed with a compound which prevents the ingress of sound. Door edges are fitted with Sorbo rubber sealing strips to ensure complete closure.

The machine base, on which equipment being tested is placed, is a solid concrete block measuring 10 ft. by 5 ft. by 2 ft. 6 in. deep resting on a 2 in. thick cork mat. It is surrounded on the four sides by a 2 in. air space and covered by insulating pads. The base is set in a pit in the laboratory's cork-covered floor.

As the volumetric capacity of the chamber is very large, ventilation in the generally accepted sense is not necessary, particularly as, under normal circumstances, only two technicians are present. However, the elaborate insulation precautions taken to eliminate and absorb noise does make the chamber, in effect, an ideal oven which is insulated against heat exchange in either direction. The whole of the power input to machines under test must of necessity be dissipated in heat within the chamber. If, for instance, a unit is being tested which is of the maximum power for which the chamber is designed, i.e., 25 b.h.p., then the heat input is equivalent to switching on about twenty 1 kW fires. Assuming no ventilation, and under these conditions, within an hour (a relatively short time in which to carry out a thorough test) the air temperature could rise as high as 500 deg. F.

The laboratory's ventilation scheme permits the control of air supply and exhaust in such a way that the temperature, under the circumstances quoted above, cannot rise above 18 deg. F. beyond the outside air temperature. The volume of air introduced into the chamber to maintain these conditions would be approximately 4,500 cub. ft. per minute. Ventilation is provided by a centrifugal fan driven by a direct-current motor which permits wide variation in fan speed, and therefore air volume, to be obtained. The fan is situated in a brick-built housing isolated from the laboratory. Air ducts are lined with acoustic felt which, together with flexible connections, prevent transmission of any slight air noise.

The filtered air introduced into the chamber is controlled by the variable-speed motor driving the exhaust fan which provides the exact volume of air necessary to dissipate the heat generated from any unit up to the limit of 25 b.h.p.

Independent radiant-convection heaters are provided to give a reasonable standard of comfort for the technicians under certain circumstances, for instance, on entering the chamber on a winter morning with the internal temperature low.

INSTRUMENTATION

A wide variety of electrical supplies has been provided to cover virtually any demand up to a rating of about 25 h.p. The services include 200/250 volt single-phase 50 cycle, 400/440 volt three-phase 50 cycle, 180 up to 346 volt single-phase 60 cycle, 300 up to 600 volt three-phase 60 cycle, and 110, 220 and 440 volt direct-current supplies. Alternative sources are available, power being taken either from the grid or from the company's own power house.

The principal instrument employed in the sound-testing of fans is a Bruel and Kjaer audio-frequency spectrum recorder, which includes both a sound-frequency analyser for automatically recording the sound spectrum in one-third octave bands, and a sound-level high-speed recorder for measuring reverberation time, sound level and the frequency response of microphones and loudspeakers. In addition, there is a portable sound-level meter for site measurements, which is used in conjunction with an analyser, and which is particularly suitable where it is necessary to pinpoint the exact frequency peaks in an analysis. Strobo-Flash electronic stroboscopes provide for speed indication and for the visual observation of fan blades, etc.; and a fan performance test set enables comprehensive measurements of air flow and pressure to be taken rapidly and accurately.

The fan acoustics laboratory at Keith Blackman's is a double-shell building, with a further air-space between the inner walls and the sound-absorbing lining of mineral wool slabs.

COMPONENTS FOR THE OCEAN FLOOR

Nowadays submarine telephone cables are fitted with submerged repeaters. They are laid in the cable every 20 to 40 nautical miles and allow the use of up to 120 telephone circuits on a single cable. An electronic amplifier forms the chief part of a repeater. Reliability is its key requirement. Repairs to a repeater—they are expected to remain on the ocean floor for 20 years—would cost tens of thousands of pounds.

Thus no sensational new technical developments were to be found in the transatlantic repeaters. All promising new technical developments about which the long term behaviour was not known had to be rejected, in favour of those components and substances that had had a good record for at least ten years. The system had to be engineered with obsolescent materials.

However, new materials and techniques are being studied. Submarine Cables, Limited, Theobald's-road, London, W.C.1, have produced a small flexible repeater solely for research purposes. Many unusual techniques were employed. And an effort was made to reduce the margin of safety to the absolute minimum without incurring certain failure. The maximum experience could thus be gained.

Irradiated polythene forms the sheath of the repeater—it has a diameter of about 4 in. Other less vulnerable parts were made of high or low quality non-irradiated polythene. For the tests a transistor oscillator replaced the usual valve amplifier. A thin-walled beryllium copper housing with brass bulkheads enclosed the oscillator. Soft solder sealed the bulkheads. The solder seam was deliberately placed near the transistors, which are easily destroyed by heat. High frequency heating was used to form the seam.

The seals used in the connections to the oscillator were known to be leaky. A covering of epoxy resin rendered them serviceable. The oscillator coil is of ferrite and was placed in the brass housing. This, however, was not oil-tight but deliberately flooded with oil at high pressure.

Rather flimsy universal joints connected the various units within the repeater. Little attention was paid to the joints because it was thought that, if the repeater was exposed to extensive twisting, the outer polythene tube would be destroyed first. Rather surprisingly the outer tube suffered a twist of about a quarter turn without damage.

The whole assembly was impregnated with oil through the cable inlets. These were then sealed off by piston valves, leaving oil under a few atmospheres excess pressure inside. The unit was tested and armoured. Finally it was passed twice through the cable ship machinery under 4 tons load and laid in the Atlantic. After a year it was recovered. The oscillator still functions.

British practice hitherto has favoured rigid repeaters. A casing of forged steel tube is used and the overall measurements of the assembled

unit are 9 ft. long and 10½ in. diameter. The rigid repeater is spliced into the cable on board ship. It is then lowered overboard.

The descent of the repeater to the sea bed is anything but steady. In experiments carried out by Submarine Cables Limited, in close co-operation with the British Post Office, Bell Telephone Laboratories, and Cable and Wireless Limited, it was shown that a rigid repeater performs a series of "hydrobatics." It makes various spins and dives. This behaviour was revealed by a "flight recorder" installed in a repeater. The recorder was capable of measuring temperature, leak rate, time, acceleration in all three directions, and the number of revolutions about the longitudinal axis. Measurements were recorded photographically. The casing was filled with nitrogen plus some hydrogen and subjected to a pressure test for a year. It was then laid in deep water for a year.

The photographic record was found to be fogged by the hydrogen but still legible. Detailed information of the various attitudes taken up by the repeater was obtained. In particular it was found that it had made about 2,000 revolutions going down and another 2,000 coming up—before the record ran out.

The bulkheads were sealed with rubber O-rings, instead of the usual brazing, in order to make the flight recorder more accessible. It is interesting to note that the polished steel surfaces, although in contact with the water, showed no sign of corrosion after one year in the fresh water of the pressure tank and one year at the bottom of the Atlantic.

One result of the experiments has been to emphasise the unexpected passivity of materials at the bottom of the sea. Pressures of nearly 4 tons per sq. in. are present. The sea bed is covered with a thick sludge which, judging from its constituents, should be extremely corrosive. Marine creatures capable of boring through steel casing may be present. (Deep sea biology is a subject still mostly unexplored.) And altogether it is something of a surprise that deep-sea cables should survive at all.

SULPHUR IN FLUE GASES

Reduction by Metallic Additives in Combustion Zone

By W. J. Peck, M.ENG., M.I.MECH.E.,* *and B. J. Zaczek*, PH.D.†

A preliminary survey of the presence of sulphur in flue gases and the possibility of controlling its harmful effects is being carried out by the authors at the Battersea College of Technology. This survey has been prompted by the considerable attention paid only to the colour of the smoke emitted by industrial and domestic users, the possibly deleterious effects of invisible components being overlooked. It was believed that by far the most objectionable components were the sulphur oxides, and an attempt was made to obtain some information from the medical profession as to the relative harm arising from SO_2 and SO_3 as far as human respiration was concerned. Unfortunately very little indeed was known, except that it was believed that SO_3 in humid atmospheric conditions was responsible for aggravating bronchial troubles.

An inquiry was next made into the possibility of estimating chemically the amount of sulphur existing as SO_2 or SO_3 in combustion gases and although there appeared to be considerable disagreement as to the most reliable method, it was decided that, for the purpose of this investigation, simplicity was a most important factor. A method similar to the one described by Corbett‡ was developed.

At this point it was realised that the problem was divided into two parts, namely:—

(*a*) the problem of atmospheric pollution, and
(*b*) the problem of the internal corrosion of boiler plant.

It was considered that if the problem of corrosion of the boiler plant could be overcome by depositing neutral sulphur products along with the ash from the fuel this would also resolve the problem of atmospheric pollution.

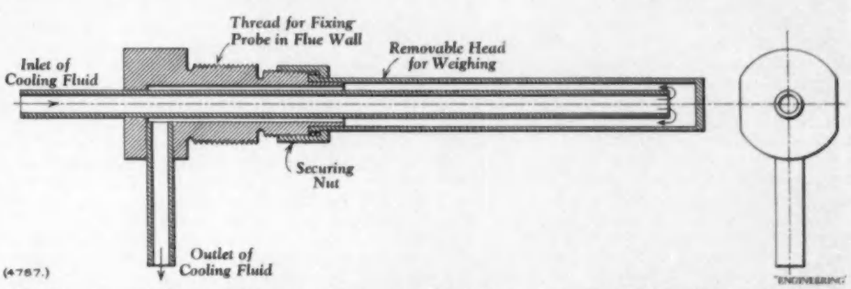
For preliminary tests it was decided to use an oil fuel because of the high sulphur content in the fuel, the high moisture content of the flue gases, and the relative ease of treating the fuel before combustion. The first set of experiments was carried out on a small oil burner using kerosine to which sulphur was added in the form of a mercaptan§ to give a sulphur content varying between 3 and 6 per cent. The resulting combustion gases were sampled at a temperature around 500 deg. F. The sample was passed through a filter paper (N.42) on which SO_3 was deposited, the SO_2 being collected in a bubbler using hydrogen peroxide. Whilst it was realised that these figures did not represent the actual composition of the flue gases at the temperature of sampling, it was felt that they could be used to investigate the reduction of sulphur content when additives were employed.

The preliminary results were sufficiently promising to warrant a change from laboratory-scale to industrial-scale experiments, and an oil-fired boiler using two burners was adapted.

In addition to the estimation of the sulphur content of the gases by the above method, a special cold probe was developed in order to measure the corrosion effects. The technique of using such a probe had to be devised because it was apparent that the existing methods of measuring the degree of corrosion were unreliable. It was found that the probe had to be highly polished, clean and carefully weighed before and after the test. Tests are at the moment being carried out to find the effects of probe temperature; the probe is also being modified for use as a dew-point meter.

It has been known that, under laboratory conditions, combustion in the presence of certain metallic salts results in a reduction of SO_3 and SO_2 in the gases. In the first series of tests it was decided to try the effect of such additives to the fuel in the form of suspensions, but this was abandoned as unsatisfactory. Finally, a mechanical injector device was developed to introduce finely pulverised additives to the combustion zone. At the present stage of the investigation it is not clear which is the best point for the injection, but the matter is under review. It has already been established that a moderate dosage gives a certain beneficial effect, but the response to the additive is progressively less as the quantity added increases so long as the total quantity is reasonably small. However, after a period of little or no improvement with increased dosage, there is suddenly a most marked effect when the dosage becomes uneconomically large. The additives tested include oxides of metals such as zinc, copper, magnesium and aluminium as well as dolomite and calcium oxide.

Following this research, a successful treatment —consisting of carefully blended chemicals, as well as a patented method of application—has been developed and marketed by the Amber Chemical Company, Limited, Albemarle-street, London, W.1, to whom one of the writers acts as technical and scientific consultant. The Central Electricity Authority have given the methods a full-scale trial at their Marchwood Power Station and the use has been extended to other stations.



Cooled probe used to determine corrosive properties of flue gases. Sulphuric acid contained in the flue gases corrodes the removable head which is weighed before and after the tests, the loss in weight being a measure of the corrosion.

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† Lecturer, Battersea College of Technology; Technical Consultant to Amber Chemical Co. Ltd.

‡ Corbett, P. F., *J. Inst. Fuel*, page 24, vol. 24 (1951).

§ Mercaptan: a sulphur alcohol, or one of a series of compounds resembling alcohols, but in which sulphur replaces the oxygen.

DIGITAL AND ANALOGUE COMPUTER SERVICE

A new computing consultancy service is available to British industry, operated by the analytical department of Short Brothers and Harland Limited, Belfast. The service offers the facilities of a newly installed English Electric DEUCE digital computer and four Short general-purpose analogue computers.

The digital computer service handles all types of problems involving higher mathematics—data reduction, production control, structural analysis and supersonic flow computations. The analogue computers are used for system analysis and simulation, such as aeroelastic problems, servo-mechanism research and the real-time representation of dynamic problems. A number of these analogue computers, designed and developed by the Short research department and now in series production, have been sold on the Continent as well as in the United Kingdom; a typical application of the instrument is an investigation of the Volkswagen suspension system under varying loading conditions, carried out by the Braunschweig Technical Institute.

The four general-purpose instruments used by Short's Analytical Department can be used separately or as a single computing engine. Each console contains 18 amplifiers, each of which is associated with a resistance/capacitance network which can be switched to any of seven transfer functions. Scaling is done by the use of decade resistors, and three significant figures are available. Facilities are available for either repetitive or real-time operation, and this significantly increases the potential use of the computer. Set-up is done on a panel which is one of the special features of this computer. The terminals of all the computing units are brought down to this panel and hence the problem of setting-up and recording is very considerably simplified. A full range of plug-in non-linear units is also available, including multipliers, function generators and limiters.

★ ★ ★

Continuing **Research and Development**

REPLACING ANALOGUE COMPUTERS

Modified Digital Machine Gives Greater Accuracy

Aircraft designers make extensive use of analogue computers. Sometimes these machines are called "simulators" or "electronic differential analysers." A particularly large example is TRIDAC, which serves the Royal Aircraft Establishment at Farnborough, where considerable experience has been gained in the application of analogue methods.

The close correspondence between the physical system being studied and the computer itself makes the analogue principle attractive. It is generally possible to incorporate actual components in the computer circuit for simulation of the complete system. However, increasing refinements in design techniques have not been matched by similar improvements in analogue computers. The answer to this problem does not lie in recourse to a general purpose digital computer, since such a machine solves a problem purely as a computation, which is relatively divorced from the original physical system. If programmed to imitate a simulator, the general purpose computer becomes intolerably slow.

Some of the speed can be retrieved by making a digital computer specially for the job. Development of such computers is the most recent project of the engineering division of the mathematical services department of the R.A.E. The machines are called digital differential analysers (D.D.A.). A very simple model, Fig. 1, has been produced to demonstrate the principles and capabilities of what will eventually be a large, fast computer.

To the user, the D.D.A. appears similar to the wheel-and-disc integrator of the old mechanical differential analyser. Its basic component is a device that performs approximate integration by finite differences. If there are inputs Δx and Δy, y is formed as the total of all previous Δy inputs. The output, Δz, is then formed so that it equals $y \Delta x$ on the average. In practical problems several integrators are required, in which case there is no longer a single input Δy but several. A common computing circuit is used in turn by all integrators, storage being provided separately for each variable. It would be too expensive to have complete computing facilities for each integrator.

The D.D.A. operates in a similar way to a general purpose digital computer in which the only part of the programme not predetermined is the interconnection to the integrators. This last feature the machine shares with the analogue computer.

The electronic D.D.A. under development by the department will compare well in capacity with the proprietary electronic computers now in use in the R.A.E. It will be much more accurate and will allow the precise repetition of results. In addition non-linear operations can be provided by a suitable grouping of standard integrators, whereas in analogue machines such operations call for special devices. Thus the department claim the advantages of increased accuracy, flexibility, and cheapness.

The demonstration model has only three integrators and is not big enough for serious work. For speed of design and construction electromechanical relays were used—reducing the operating speed considerably. Two storage registers (Y and R) are provided for each integrator, Fig. 2, the Y register holding y, the running total of the Δy inputs. For ease of multiplication of y and Δx, all inputs and outputs have only two possible values, ± 1. After y has been brought up to date, $y \Delta x$ (which is in fact either $+y$ or $-y$) is added to the existing content of the R register. The register would therefore contain $\Sigma y \Delta x$ (the finite difference approximation to $\int y\,dx$) in parallel digital form were it not that the most significant digit in R is removed to become the Δz output of the integrator. The contents of R therefore represent the remainder when $+2^n$ or -2^n is taken as a rounded-off value of the increment in $\Sigma y \Delta x$. This remainder is preserved until the next cycle, where it affects the next value of Δz in a manner designed to avoid a build up of the round-off error.

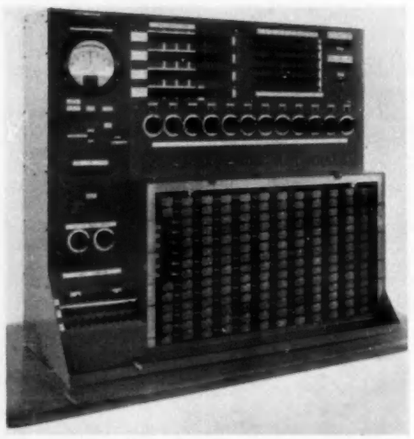

Fig. 1 The demonstration model of the digital differential analyser has only three integrators. Electromechanical relays were used for speed of design and construction.

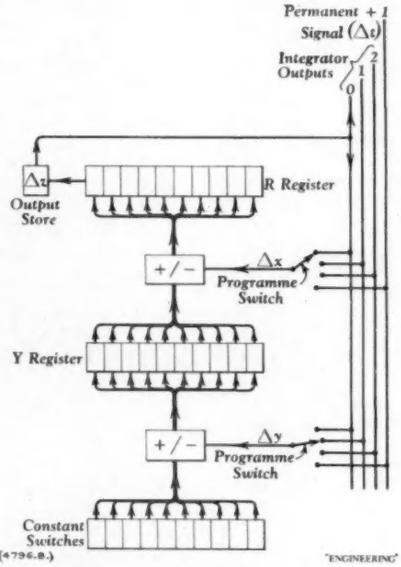

Fig. 2 Two storage registers are provided for each integrator. All inputs have only two possible values, ± 1, in order to facilitate multiplication.

Atomic Review

On Manoeuvres

A power plant that is successful on dry land may not be equally successful at sea. Nuclear reactors have yet to prove themselves as commercial units for ship propulsion, and in seagoing conditions certain problems arise not met in stationary installations. Thus a ship must be able to manoeuvre rapidly, calling for sudden changes in steam requirement; and the power plant must continue to function however violent the motions of the ship. These topics have been discussed in two recent papers: one by Dr. T. W. F. Brown of Pametrada has already been extensively treated in ENGINEERING (Atomic Review, October 4 and November 1); the other, "The Nuclear Propulsion of Ships," by Sir Christopher Hinton and Mr. R. V. Moore, was presented before the Joint Nuclear Marine Propulsion Panel on November 27. The sections on manoeuvring in both papers are summarised below; the first note is taken from Dr. Brown's paper and Figs. 1 and 2 show Pametrada models illustrating the arrangement of large (gas-cooled graphite-moderated) and small (pressurised-water) reactors in ships' hulls. Fig. 3 shows the two reactor models side by side.

Manoeuvring and Control

A ship is not a base load power station and rapid manoeuvring is required from time to time. Under such conditions the reactor output should remain sensibly constant as thermal cycling will seriously reduce the life of the fuel elements. These conditions would be met by spill valves passing the steam from the heat exchangers not required by the turbines by way of water sprays to a dump condenser at atmospheric pressure. (Since fuel costs for a nuclear plant are low and ships work at constant power for long periods at a time, the cost of dumping steam in this way has little effect on operating cost.) As a fairly large temperature rise in the circulating water can be tolerated in an atmospheric condenser the size can be kept small.

With a dump condenser fitted, the basic control variable in the reactor would be outlet gas temperature from the reactor, since this ensures constant temperature working of the pressure circuit. Constant can temperature would not be so advantageous, as a change in power would involve a redistribution of the temperatures within the fuel. Reactor control down to 10 per cent. full power should be possible but must follow the power change and not initiate it. Axial-flow gas circulators with Ward Leonard control would appear to be best but if the cost and commutation trouble prove difficult, steam-turbine drive could be used. The auxiliary blower for cooling down would be motor driven, the power being provided by an auxiliary oil-engine driven generator. There could also be an emergency battery system. In the case of a PWR plant, similar remarks would apply to the drive for the cooling-water circulating pumps.

Poisoning of the reactor by xenon build-up is important if the reactor is to be shut down at all. The deciding factor is the flux level corresponding to rating and enrichment. Generally a flux less than 10^{13} neutrons per sq. cm. per sec. can be considered fairly safe; above this value the xenon effect becomes very marked with natural uranium. It might be as much as 24 or 30 hours before the reactor could be started up again. Xenon poisoning is treated in greater detail in the following note.

Xenon Poisoning

When the uranium nucleus undergoes fission, among the resulting fragments occurs an unstable isotope of iodine (iodine135) the decay product of which, xenon 135, has a profound effect on

the control behaviour of the reactor. Xenon 135 has the largest affinity for neutrons of any isotope. Fortunately it is formed in very small quantities and, being unstable, its life is limited. It is destroyed in one of two ways, either by radioactive decay to caesium 135—a stable isotope—or by neutron capture to xenon 136, which has a relatively low affinity for thermal neutrons. Equilibrium concentration is reached when the rate of formation of xenon 135 is equal to the rate of its disappearance, the actual value depending on the neutron flux at which the reactor is operating. In order to maintain the chain reaction when the reactor is operating at full power, sufficient enrichment must be included in the fuel to compensate for the neutron loss by xenon absorption.

In addition, peculiar effects arise when the nuclear power, and hence the neutron flux, is reduced. For example, if the reactor is shut down the neutron flux collapses and the capture mechanism, by which the equilibrium concentration of xenon 135 is in part controlled, disappears. The iodine 135 concentration decays exponentially, from its equilibrium value at a rate determined by its decay constant and the xenon 135 builds up at the same rate. Since the half-life of xenon 135 (9·2 hours) is greater than that of iodine 135 (6·7 hours), the xenon 135 concentration builds up above its normal equilibrium value with a consequent further loss of reactivity. Eventually all the iodine changes into xenon, which in turn changes into caesium and reactivity is released. A similar effect occurs, if, instead of the power being shut down, it is reduced.

The build-up effect of the xenon poison when the nuclear power is reduced becomes accentuated as the rating of the fuel is increased, and since marine reactors will tend to be highly rated to reduce their weight per horse-power, the effect is serious in this application. It can be overcome, however, in a number of ways. One obvious approach is to add more enrichment to the fuel, mopping up the excess neutrons under normal running conditions in the control rods and withdrawing the control rods when the excess reactivity is required to over-ride the xenon poison. While this might well be an acceptable solution with low-rated reactors requiring little over-ride, with reactors of high rating, careful consideration must be given to whether the xenon over-ride facility is worth the very expensive extra investment in enriched fuel. If xenon over-ride is not provided, the effect on the manoeuvrability of the ship is twofold. First, if the reactor is shut down, a considerable period of time must elapse before it can be restarted. Secondly, the rate at which reactor power may be reduced is severely limited.

Auxiliary Plant

From the point of view of being able to manoeuvre the ship at all times, there seem at first sight some very awkward characteristics, especially for a ship fitted with a single reactor. The difficulty can be overcome, however, with some additional conventional plant. To cover the case of reactor shut-down, it is necessary to provide another source of standby power. This need be only a small steam or Diesel installation, sufficient to give the ship steerage way at sea and provide the heat and power requirement in port in the event of the reactor being shut down for maintenance. Inadvertent shut-downs in practice are very rare, so that the call for standby power at sea would be equally infrequent.

Heavy Seas

The reactor and machinery installation in a ship are, of course, subjected to acceleration forces and fluctuating deflections imposed by cargo loading and heavy weather, to which shore installations are not subject. In the super-tanker study discussed by Sir Christopher Hinton and Mr. R. V. Moore, the resulting accelerating forces, assuming harmonic motion, were calculated for roll, pitch, heaving and vibration, as defined by conservative values of amplitude and period. In addition, it was assumed that these motions occur simultaneously. No difficulties were found in designing to withstand the resulting forces. There is an obvious advantage in locating the centre of gravity of the reactor and its heavy shielding as near as possible to the centre of roll of the ship to minimise the rolling acceleration forces. The greatest deflection of the ship's structure is that due to longitudinal bending. Again, where this quantity was evaluated, there appeared to be no insuperable difficulties from the design point of view.

It is considered desirable to design the reactor unit to remain structurally stable in the event of the ship capsizing and the control rods so that they will function in any normal or abnormal position of the ship. In general, although the heavy concentrated loads of the reactor and its shielding require special design measures for its support within a ship's hull, provided the design of the plant and the hull are properly integrated, it is not thought that any overwhelming engineering difficulties would be encountered.

Charging and Discharging Fuel

For charging and discharging the fuel of a shore-based reactor, it has become the practice to design so that this may be carried out on a continuous basis while the reactor remains operating at full power. This system may become acceptable marine practice. Alternatively, since faulty fuel elements are rare, on condition that adequate means are provided for dealing with them if they arise at sea, the normal discharging of the uranium could be carried out in port. With a small reactor, the complete core could be periodically replaced. With a larger reactor, turn-round time of the ship could be reduced and a better fuel economy realised if a proportion of the core was discharged periodically, so approximating to the continuous charge and discharge scheme.

General Notes

Nuclear Power Station for Italy

The Nuclear Power Plant Company Limited have received from Ing. Mattei, president of Ente Nazionale Idrocarburi, Rome, a letter of intent to negotiate the construction of nuclear power stations in Italy, and also to conclude a long term agreement for mutual co-operation on the design and development of power reactors;

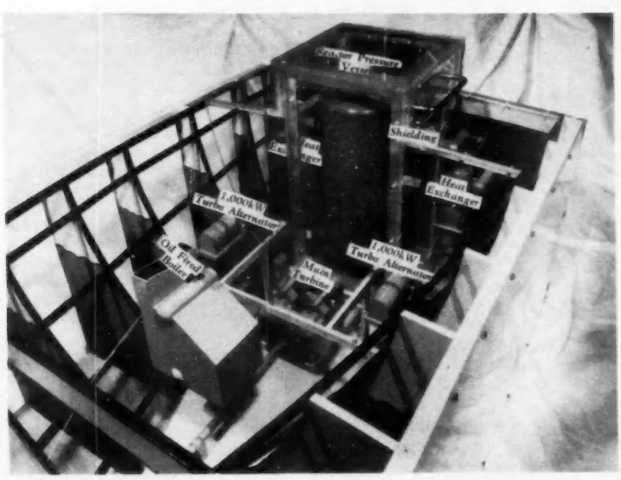

Fig. 1 Model constructed by Pametrada showing the disposition of a large reactor (presumably of gas-cooled graphite-moderated design) and associated plant within a ship's hull. The reactor projects above the deck.

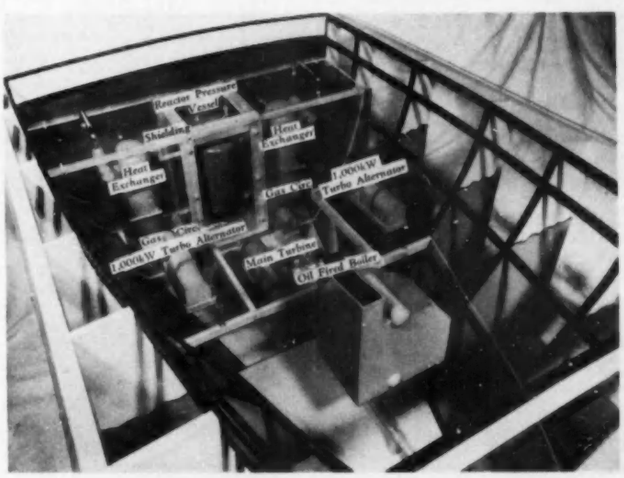

Fig. 2 Arrangement of a small reactor (possibly a pressurised-water reactor) within a ship's hull. The wavy lines on the panels outside the hull framework indicate the water line of the ship at loaded draught.

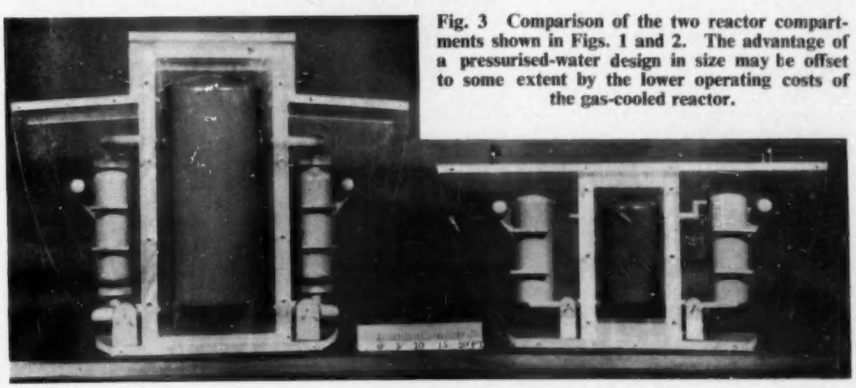

Fig. 3 Comparison of the two reactor compartments shown in Figs. 1 and 2. The advantage of a pressurised-water design in size may be offset to some extent by the lower operating costs of the gas-cooled reactor.

Continuing Atomic Review

the agreement will be made between N.P.P.C. and AGIP Nucleare, a subsidiary of E.N.I. and will refer to reactors of the gas-cooled type.

The first station to be constructed under this arrangement will have an output of 200 MW and will involve the manufacture in the United Kingdom of considerable quantities of plant, said to represent one-third of the total £26 million understood to be involved. The Nuclear Power Plant Company will be responsible for the overall design and satisfactory commissioning of the station, while AGIP Nucleare will place all local contracts and will carry out the site erection. As Italian knowledge of the special plant grows so will that country's participation in manufacture increase. The technical agreement involves the exchange of information.

The company is already engaged on the construction of a power station at Bradwell-on-Sea, Essex, which will have two reactors, each with a guaranteed output of 150 MW. The single reactor for the Italian station will be of the same overall dimensions as the Bradwell reactors, and the increase in output reflects the research and development that has taken place since the Bradwell design was accepted a year ago.

Other Overseas Prospects

Another Italian government-controlled organisation, S.E.N.N., is also expected to order a Calder Hall type of reactor. Other possible purchasers are Holland, where a gas-cooled graphite-moderated reactor is planned for operation in North Brabant by 1962, and Germany, which is to use a similar reactor for its first major project. The negotiations with Japan also appear to be approaching a satisfactory conclusion.

Nuclear Ship Contract

The construction of America's first nuclear powered merchant ship is now in hand. The United States Government has awarded the contract to the New York Shipbuilding Corporation, Camden, New Jersey. The ship, the N.S. Savannah, which will cost 20·9 million dols. (£7·5 million), is due for launching in 1959 and service in 1960. The loaded displacement will be some 21,800 tons and the passenger complement 60. The American Babcock and Wilcox company will build the nuclear propulsion plant, employing a pressurised-water reactor, under a separate contract amounting to 9 million dols. (£3·2 million).

Marine Aqueous Homogeneous Reactor

A preliminary design for an aqueous homogeneous reactor plant suitable for marine propulsion has been described in a paper recently read before the United States Society of Naval Architects and Marine Engineers. The author, Mr. Cecil B. Ellis of the Foster Wheeler Corporation, believes this system to come closer to competitive operation than any other reactor, given to-day's technology. Mr. Ellis emphasised that costs for building and operating nuclear plant are still imperfectly known.

Fairey Join Nuclear Group

Arrangements have now been completed between the Fairey Aviation Company, Limited, and Atomic Power Constructions Limited, whereby the Fairey Aviation Company becomes a full member of the fifth Atomic Group formed early this year by agreement with the United Kingdom Atomic Energy Authority. Mr. G. W. Hall, F.R.Ae.S., chairman and managing director of the Fairey Aviation Company, will be joining the Board of Atomic Power Constructions. The Fairey Aviation Company has been intimately connected with atomic energy developments for the past 10 years. Contracts have been undertaken both at Hayes and Stockport for the U.K.A.E.A., and at Springfields, Windscale, Capenhurst, Dounreay, and the Calder Hall Power Station project, in which the company was responsible for the production of the fuel containers.

Nuclear Energy in Britain

An overall survey of British work on the study and development of nuclear energy has been published by the Central Office of Information (H.M. Stationery Office, price 3*s*.). C.O.I. reference pamphlet 28, *Nuclear Energy in Britain*, covers the following subjects: origins and early development, present organisation, the nuclear power programme and its background, isotopes and radioactive materials, materials procurement, the role of industry, exporting to the world, and the future. The booklet also includes a list of United Kingdom Atomic Energy Authority reactors, a bibliography, a glossary, and the table of United Kingdom organisations and firms concerned with nuclear power reproduced below.

TABLE.—*United Kingdom Organisations and Firms Concerned with Nuclear Power*

(A) NUCLEAR POWER INDUSTRIAL GROUPS

Name of consortium	Participating companies	Head office	Remarks
A.E.I.-John Thompson Nuclear Energy Co. Ltd.	Associated Electrical Industries Ltd. John Thompson Ltd. in association with Balfour Beatty & Co. Ltd., and John Laing & Son Ltd.	Oak House, Sale, Cheshire	Has received the contract for one of the first commercial nuclear power stations to be built for the United Kingdom electricity authorities—that at Berkeley in Gloucestershire. Is building its own research reactor—MERLIN—one of which type has also been ordered in Western Germany.
Atomic Power Constructions Ltd.	Richardsons Westgarth & Co. Ltd. (generating plant) International Combustion (Holdings) Ltd. (steam-raising equipment) Crompton Parkinson Ltd. (electrical apparatus) Trollope & Colls Ltd., in association with Holland & Hannen and Cubitts Ltd.	28-30 Theobalds Road, London, W.C.1	Formed late in 1956. Has since been joined by Fairey Aviation Ltd. and Elliott Bros. (London) Ltd.
English Electric-Babcock & Wilcox-Taylor Woodrow	The English Electric Co. Ltd. Babcock & Wilcox Ltd. Taylor Woodrow Ltd.	Inquiries to: English Electric Co. Ltd., 28 Kingsway, London, W.C.2	Taylor Woodrow were the main civil contractors for the Calder Hall station. The group has been awarded the contract to build the Central Electricity Authority's commercial station at Hinkley Point in Somerset.
G.E.C.-Simon-Carves Atomic Energy Group	The General Electric Co. Ltd. Simon-Carves Ltd. The Motherwell Bridge & Engineering Co. Ltd. John Mowlem & Co. Ltd.	Fraser & Chalmers, Engineering Works, Erith, Kent	Has been awarded the contract for the South of Scotland Electricity Board's first nuclear power station, at Hunterston, Ayrshire, Scotland.
Nuclear Power Plant Co. Ltd.	The Parolle Electrical Plant Co. Ltd. (consisting of C. A. Parsons & Co. Ltd. and A. Reyrolle & Co. Ltd.) Head Wrightson & Co. Ltd. (heat exchange equipment) Sir Robert McAlpine & Sons Ltd. (civil engineering) Whessoe Ltd. (pressure vessels) Strachan & Henshaw Ltd. (mechanical engineering) Alex. Findlay & Co. Ltd. (constructional engineers) Clarke, Chapman & Co. Ltd. (steam-raising equipment)	Heaton Works, Newcastle-upon-Tyne, 6, Northumberland	Has been awarded the contract for the Bradwell commercial nuclear power station in Essex. One of the constituent firms—Head Wrightson—was awarded the contract for a heavy water research reactor for the Australian Atomic Energy Commission and offers similar reactors costing about £1 million. The group has also been awarded a contract to build a 200 MW nuclear power station in Italy.

(B) OTHER GROUPS ENGAGED IN NUCLEAR ENERGY RESEARCH AND PRODUCTION

Hawker Siddeley John Brown Nuclear Construction Ltd.	Hawker Siddeley Group John Brown & Co. Ltd.		Formed for investigation and research in the field of atomic power, the company will concentrate on smaller nuclear power units, but the first task will probably be connected with marine propulsion and especially the construction of a nuclear power tanker.
Hawker Siddeley Nuclear Power Co. Ltd.		Sutton Lane, Langley, Bucks.	Formed in January, 1956, and has carried out research on reactors suitable for propulsion.
	Babcock & Wilcox Ltd. Cammell Laird & Co.		These two companies have been collaborating on the nuclear propulsion of ships since April, 1956.
Humphreys & Glasgow Ltd.	Humphreys & Glasgow Ltd. Daniel Adamson & Co. Ltd. Alco Products Inc.	Humglass House, Carlisle Place, London, S.W.1	Working arrangement whereby the United Kingdom firm produces small pressurised water reactors, partly designed by the United States firm Alco Products Inc., of 5-10 MW for use in communities of 20,000 inhabitants.
Mitchell-A.M.F.	Mitchell Engineering Ltd. A.M.F. Atomics Inc.	1 Bedford Square, London, W.C.1	Mitchell Engineering Ltd. is the main contractor for the U.K.A.E.A. reactors at Annan, Dumfriesshire, Scotland. These firms jointly offer closed cycle boiling water reactors for all parts of the world. Broadly, Mitchell supplies the engineering material and construction work, while A.M.F. is responsible for the core design, control rod mechanism and instrumentation, though efforts are being made to have the control rod mechanism made in the United Kingdom for sterling area orders.
Vickers Nuclear Engineering Ltd.	Vickers Ltd. Rolls-Royce Ltd. Foster Wheeler Ltd.	Vickers House, Broadway, London, S.W.1	Formed in February, 1956, to work on the application of nuclear energy to marine propulsion.
British Acheson Electrodes Ltd.			Produces graphite for nuclear reactor furnaces.
Nuclear Graphite Ltd. Nuclear Power Plant Co. Ltd.	A.E.I.-John Thompson Nuclear Energy Co. Ltd. Morgan Crucible Co. Ltd. (As above)		Specialise in machining graphite blocks to special requirements.

(C) GOVERNMENT AND OTHER BODIES

Ministry of Power, Thames House South, Millbank, London, S.W.1.
United Kingdom Atomic Energy Authority, St. Giles Court, London, W.C.2.
Nuclear Energy Trade Associations' Conference, 32 Victoria-street, London, S.W.1.
British Nuclear Energy Conference, Great George-street, London, S.W.1.

(D) CONSULTANTS

Kennedy and Donkin, 12 Caxton-street, London, S.W.1.
Merz and McLellan, 32 Victoria-street, London, S.W.1.
Ewbank and Partners, 10 Grosvenor-place, London, W.1.
Preece, Cardew and Rider, 8-12 Queen's-gate, London, S.W.1.

These firms of consultants are working with the U.K.A.E.A. and with the various industrial groups on the specification, planning and inspection of nuclear power station construction in Britain. They are in a position to assist governments wanting to start nuclear power programmes, especially those which have not yet decided at what stage to introduce nuclear power into their system. For these they can give independent advice on alternative schemes, possible suppliers of equipment, siting of stations, costs and so on.

Production

FORD MOTOR CO.'S ADVANCED NEW FOUNDRY

Forming part of an ambitious expansion programme, the new Thames Foundry of the Ford Motor Company, Limited, at Dagenham, Essex, is now practically completed and will soon be in full production. The cost of the foundry is given as £8 million and it is emphasised that in design, layout, mechanisation, and standard of working conditions it is one of the most advanced of its type in the world. Initially the new foundry will need 1,800 operators working in two shifts, who will be transferred from the existing Dagenham Foundry, which will continue working with about half its present complement of workpeople, producing malleable iron and miscellaneous small grey-iron castings and crankshafts. There will be no labour displacement.

The Thames Foundry is planned for a daily production of approximately 400 tons of castings, or about two-thirds of the total Ford Company's output. For the most part it will manufacture cylinder blocks and heads and the larger iron castings for the firm's tractors, including the new Fordson Dexta machine.

The two buildings constituting the new foundry are built on piles on a 22-acre plot and running between them are enclosed high-level conveyor passages. An aerial view of the installation is shown in Fig. 1. Fig. 2 shows the arrangement of the main working floor in plan, and Fig. 3, a view of the fettling area. The main foundry building measures 1,200 ft. in length by 180 ft. in width, and reaches a height of 70 ft. It incorporates the operations of melting, moulding, core-making, and fettling. The adjoining ancillary building, measuring 700 ft. by 60 ft. by 70 ft., contains the sand-handling and drying and the casting-cooling, grinding and cleaning sections. The sand-drying plant is equipped with a 35 tons capacity wagon tipper and two 12½ tons per hour capacity sand driers. The total floor area of the two buildings is 533,200 sq. ft.

The main building is a two-floor flat-roofed structure, the lower or ground floor containing the maintenance equipment, offices, an air-compressor house, stores and all the employee amenities, including heated locker rooms, toilets, showers and a canteen. On the first or main operating floor, seen in plan in Fig. 2, bays of 60 ft. by 60 ft. have been chosen as the design basis, and steel columns at 60 ft. centres support lattice girders forming the fabric of the building. These are utilised for carrying much of the sand-system and mono-rail conveyor equipment and the material-storage hoppers, thereby eliminating individual supporting columns and providing the maximum free working space at floor level. Sub-stations, dust collectors, fan rooms, sluices and ventilation chambers are situated on the roof of the main structure.

The heavy manual duties normally associated with foundry work have been eliminated wherever possible and mechanical-handling equipment installed. Pig iron and coke reach the foundry in railway wagons and special consideration has been given to the handling of the coke to keep breakages down to a minimum. A telpher system lifts containers from the wagons and conveys the coke to storage hoppers adjacent to the cupolas to avoid excessive handling.

The metal, comprising pig iron, steel and return scrap is melted in four 108-in. diameter coke-fired water-cooled hot-blast cupolas, fitted with skip chargers. Two cupolas are in service at one time during each of the two working shifts. Each cupola has an 8 ton hot-metal receiver which pours the hot metal into ladles. Ten 2,000 lb. ladles and four 1,000 lb. ladles are suspended from a mono-rail conveyor and are electrically towed and hoisted for transferring the molten metal to the moulds at the pouring stations. In addition, there is a pig-casting machine for surplus metal, handling some 20 tons per hour.

Fig. 1 Aerial view of the new Thames Foundry of the Ford Motor Co. Ltd. at Dagenham. The main foundry building on the right is 1,200 ft. long by 180 ft. wide. It is connected by enclosed high-level conveyor passages to the ancillary building on the left.

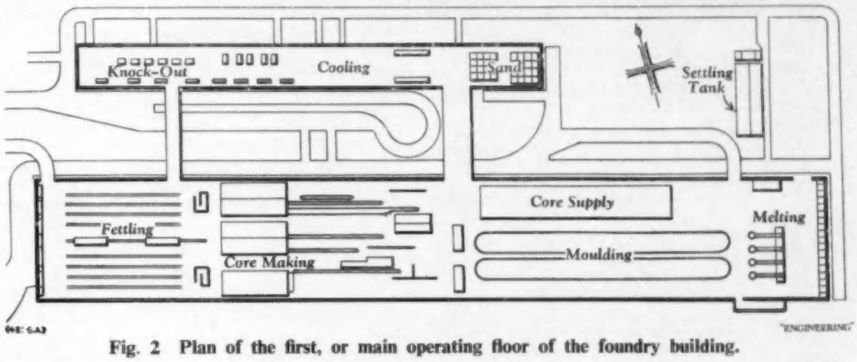

Fig. 2 Plan of the first, or main operating floor of the foundry building.

The two moulding lines are fed from their own automatic sand systems, each line being equipped with four 50 tons per hour sand mullers. Each line incorporates 8 semi-automatic moulding machines working within a continuous 800 ft. pallet mould conveyor.

After pouring, the castings are removed from the drag, or lower, portion of the mould by means of special hook carriers suspended from a mono-rail cooling conveyor situated vertically above each mould conveyor. The latter delivers the castings through the right-hand connecting passage (Fig. 2) to the ancillary building, where, after cooling for some three hours the sand and cores are shaken out from the castings by vibrators before they are passed through a battery of grinding machines which remove any metallic surface irregularities. The castings then return to the main foundry building on mono-rail type conveyors by way of the left-hand connecting passage. They are finally cleaned and finished on eight fettling lines and, if required, are given a water test. Moulding sands are reclaimed after use and recirculated.

Cores are formed and baked at least 24 hours ahead of the moulding process. The core shop is located centrally in the main building as will be noted in Fig. 2. The core sand is mixed with oil and flour at a central high-level station; this operation is completely automatic and is actuated by the insertion of a punched card into the weighing system. All the cores are made by 39 semi-automatic vertical core-blowing machines. The cores produced are taken by conveyor to five continuous horizontal ovens for baking, after which their faces are coated with a core wash and finally dried in three horizontal ovens.

Fig. 3 General view down the fettling area of the new foundry in which castings are finally cleaned and finished and made ready for the Dagenham machine shops. The castings are also given a water test in this shop if required.

One outstanding feature of the new foundry is the heating, ventilating and air-purifying system which warms or cools the building and changes the whole air content more than seven times an hour. In the moulding and fettling departments the air is changed as many as 16 times an hour. All air entering the building is cleaned and warmed in the winter and fan-cooled in the summer. Special dust-extraction systems collect dust at the source and deliver it by ducting to wet-type separators. A sluicing system receives the slurry produced together with slag from the cupolas and carries it to settling tanks and ponds.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Electrical Water Treatment," by A. G. Freeborn. North London Branch. Queen's Head, 677 Green Lanes, Harringay, N.4. Wed., Dec. 4, 7.45 p.m.

British Institution of Radio Engineers

CARDIFF
"Demonstrations on Aerial Circuits," by H. V. Sims. South Wales Section. College of Technology and Commerce, Cathays Park, Cardiff. Wed., Dec. 4, 6.30 p.m.

British Interplanetary Society

LONDON
"The Physical Nature of the Surface of the Moon," by Dr. G. Fielder. Caxton Hall, off Victoria-street, S.W.1. Sat., Dec. 7, 6 p.m.

Building Centre

LONDON
Film: "Roofs over Britain," exhibited by Redland Tiles Ltd. Wed., Dec. 4, 12.45 p.m.

Chemical Society

BRISTOL
"Design and Operation of Waste-Heat Boilers," by Captain W. Gregson. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., Dec. 5, 6.30 p.m.
GLASGOW
"William Ramsay: a Glasgow Man," by Dr. A. Kent. Glasgow Branch. Royal College of Science and Technology, Glasgow. Fri., Dec. 6, 7.15 p.m.
HULL
"Water-Repellency," by Professor N. K. Adam. Hull Branch. Organic Chemistry Lecture Theatre, The University, Hull. Thurs., Dec. 5, 5 p.m.

Combustion Engineering Association

LONDON
"Effectiveness of Instrumentation for Combustion and Process Work," by R. Clare, at 10.30 a.m. "Nuclear Power Reactors," by W. R. Wootton, at 2.30 p.m. Southern Region. St. Ermin's Hotel, Caxton-street, S.W.1. Wed., Dec. 4.

Illuminating Engineering Society

CARDIFF
"Road Vehicle Lighting," by K. J. Jones. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Dec. 5, 6 p.m.
EDINBURGH
"Acrylic Plastics in Modern Interior Lighting," by P. H. Collins. Edinburgh Centre. Y.M.C.A., 14 South St. Andrew-street, Edinburgh. Wed., Dec. 4, 6.15 p.m.
GLASGOW
"Acrylic Plastics in Modern Interior Lighting," by P. H. Collins. Glasgow Centre. Lighting Service Bureau of Scotland, 29 St. Vincent-place, Glasgow, C.1. Thurs., Dec. 5, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"Lighting of London Airport," by J. G. Holmes. Newcastle-upon-Tyne Centre. Department of Electrical Engineering, King's College, Newcastle-upon-Tyne. Wed., Dec. 4, 6.15 p.m.

Incorporated Plant Engineers

LONDON
"Impact of Automation on the Plant Engineer," by J. F. Coales. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Dec. 3, 7 p.m.*
EDINBURGH
Open Meeting. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Dec. 3, 7 p.m.
LEICESTER
"The Research, Information and Training Activities of the Production Engineering Research Association," by D. D. Morgan. Leicester Branch. Bell Hotel, Leicester. Wed., Dec. 4, 7 p.m.
NOTTINGHAM
Film Display. East Midlands Branch. County Hotel, Theatre-square, Nottingham. Wed., Dec. 4, 7 p.m.
SOUTHAMPTON
Discussion on "Photography in Engineering." Southern Branch. Polygon Hotel, Southampton. Wed., Dec. 4, 7.30 p.m.

Institute of Fuel

LONDON
"Manufacture of Town Gas from Liquid or Gaseous Fuels," by E. J. Lawton. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Dec. 4, 5.30 p.m.*
LIVERPOOL
"Operation and Maintenance of Fuel Economisers," by H. J. Gardner. Merseyside Sub-Section. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Thurs., Dec. 5, 7 p.m.
NEWCASTLE-UPON-TYNE
"How the Clean Coal Idea Arose," by Dr. R. Lessing. North Eastern Section. King's College, Newcastle-upon-Tyne. Mon., Dec. 2, 6.30 p.m

Institute of Metals

LONDON
Powder Metallurgy Joint Group Inaugural Meeting. "Recent Developments in Powder Metallurgy," by Dr. Ivor Jenkins, at 10.30 a.m. Various short papers on "Production and Quality of Metal Powders," at 11.30 a.m. and 2.15 p.m. Church House, Great Smith-street, S.W.1. Wed., Dec. 4.
BRISTOL
"Design and Operation of Waste-Heat Boilers," by Captain W. Gregson. Chemistry Department, The University, Bristol. Thurs., Dec. 5, 6.30 p.m.

Institute of Packaging

LONDON
"Electronics in Packaging," by C. E. G. Bailey. Southern Area. Agriculture House, Knightsbridge, S.W.1. Wed., Dec. 4, 6.30 p.m.
GLASGOW
"Metal Drums," by T. W. Carpenter. Scottish Area. More's Hotel, Glasgow. Mon., Dec. 2, 7 p.m.

Institute of Petroleum

LONDON
"Recent Engine Developments in Relation to Fuels and Lubricants," by D. Downs. 61 New Cavendish-street, W.1. Wed., Dec. 4, 5.30 p.m.*

Institute of Physics

LONDON
"Structural Imperfections in Metals and Their Effect on Mechanical Properties," by Professor N. F. Mott. Non-Destructive Testing Group. Fri., Dec. 6, 6 p.m.*
CARDIFF
Annual General Meeting. "Microwave Triodes," by Professor M. R. Gavin. Physics Department, University College of South Wales and Monmouthshire, Cardiff. Fri., Dec. 6, 5.15 p.m.
LIVERPOOL
"Čerenkov Radiation," by Dr. J. V. Jelley. Liverpool and North Wales Branch. Department of Electrical Engineering, The University, Liverpool. Fri., Dec. 6, 7 p.m.*
NEWCASTLE-UPON-TYNE
"The Physics of Fibres," by Dr. A. B. D. Cassie. North Eastern Branch. King's College, Newcastle-upon-Tyne. Wed., Dec. 4, 6.15 p.m.*

Institute of Refrigeration

LONDON
"Development of a Quick-Freezing Plant for Distant-Water Trawlers," by G. C. Eddie, R. T. Hales and D. W. Higham. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., Dec. 5, 5.30 p.m.*

Institute of Road Transport Engineers

CAMBRIDGE
"Two-Way Radio as an Aid to the Control of Goods and Passenger Vehicles," by E. N. Farrar. Eastern Centre. Golden Hind Hotel, Cambridge. Tues., Dec. 3, 7 p.m.
LIVERPOOL
"Use of Plastics in Road Transport," by M. D. Curwen. West Regional Centre. Liverpool Architectural Society, Bluecoat Chambers, School-lane, Liverpool, 1. Tues., Dec. 3, 7.30 p.m.

Institution of Chemical Engineers

LONDON
"Shell Gasification Process and Its Application to Industry," by M. J. Gattiker. Geological Society, Burlington House, Piccadilly, W.1. Tues., Dec. 3, 5.30 p.m.*

Institution of Civil Engineers

LONDON
"Snow Clearance Problems in Switzerland," by August Knobel. Tues., Dec. 3, 5.30 p.m.*
MANCHESTER
"Railway Diesel Traction," by A. B. Henderson. North Western Association. Engineers' Club, Manchester. Thurs., Dec. 5, 6.30 p.m.

Institution of Electrical Engineers

LONDON
"Aspects of Half-Wave Magnetic Amplifiers," by G. M. Ettinger; "Dekatrons and Electro-Mechanical Registers Operated by Transistors," by Dr. G. B. B. Chaplin and R. Williamson; and "Transistor Input Stages for High-Gain D.C. Amplifiers" and "A Transistor High-Gain Chopper Type D.C. Amplifier," by Dr. G. B. B. Chaplin and A. R. Owens. Measurement and Radio Sections. Tues., Dec. 3, 5.30 p.m.*
"Advanced Types of Power Reactors," by Dr. J. V. Dunworth. In conjunction with the British Nuclear Energy Conference. Thurs., Dec. 5, 5.30 p.m.*
"Man/Machine Relationships," by W. H. Dunkley. London Graduate and Student Section. Wed., Dec. 4, 6.30 p.m.*
BIRMINGHAM
"Electronic Control of Machine Tools," by D. T. N. Williamson. South Midland Centre. James Watt Memorial Institute, Birmingham. Mon., Dec. 2, 6 p.m.*
HULL
"Diesel-Electric Traction," by R. S. Wignall. North Midland Centre. Yorkshire Electricity Board, Ferensway, Hull. Thurs., Dec. 5, 6.30 p.m.
LEEDS
"Use of Transistors in Radio and Television," by Dr. A. J. Biggs and E. Wolfendale. North Midland Centre. 1 Whitehall-road, Leeds. Tues., Dec. 3, 6.30 p.m.
MANCHESTER
"Cathodic Protection," by L. B. Hobgen, K. A. Spencer and P. W. Haselgrave. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Dec. 3, 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Free Piston Progress," by F. A. I. Muntz and M. Barthalon. Tues., Dec. 3, 6.30 p.m.*

Institution of Heating and Ventilating Engineers

LONDON
"Space Heating by Means of Electric Thermal Storage Heaters of the Block Type," by Leslie Shepherd. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Tues., Dec. 3, 6 p.m.*

Institution of Highway Engineers

LONDON
"Roads from the Beginning," by E. J. R. Kennerell. 11 Upper Belgrave-street, S.W.1. Fri., Dec. 6, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion: "Are Crankshaft Torsional Vibration Problems Things of the Past?" Internal Combustion Engine Group. Fri., Dec. 6, 6.45 p.m.*
BRISTOL
"Pneumatic Suspensions for Motor Vehicles," by J. Sainsbury. Western A.D. Centre. Royal Hotel, Bristol. Thurs., Dec. 5, 6.45 p.m.
COLCHESTER
Thomas Hawksley Lecture: "Engineering Problems in Connection with the Industrial Application of Nuclear Energy," by Sir Claude D. Gibb. Eastern Branch. Red Lion Hotel, Colchester. Tues., Dec. 3, 7.30 p.m.
EDINBURGH
Thomas Hawksley Lecture: "Vibration," by Professor J. P. den Hartog. Scottish Branch. North British Hotel, Edinburgh. Fri., Dec. 6, 6.30 p.m.
GLASGOW
"Vibration," by Professor J. P. den Hartog. Royal College of Science and Technology, Glasgow. Thurs., Dec. 5, 7.30 p.m.
LUTON
"Suspension of Internal-Combustion Engines in Vehicles," by M. Horovitz. Luton A.D. Centre. Town Hall, Luton. Wed., Dec. 4, 7.30 p.m.
MANCHESTER
"Vibration," by Professor J. P. den Hartog. North Western Branch. Engineers' Club, Albert-square, Manchester. Wed., Dec. 4, 6.45 p.m.
NEWCASTLE-UPON-TYNE
"Vibration," by Professor J. P. den Hartog. North Eastern Branch. Neville Hall, Newcastle-upon-Tyne. Mon., Dec. 2, 6 p.m.

Institution of Naval Architects

LONDON
Parsons Memorial Lecture: "Aspects of Propellers for the Royal Navy," by Dr. R. W. L. Gawn. Thurs., Dec. 5, 4.45 p.m.*

Institution of Production Engineers

HALIFAX
"Increased Automation of Existing Production Lines," by J. B. Jay. Halifax and Huddersfield Section. White Swan Hotel, Halifax. Wed., Dec. 4, 7.30 p.m.

Institution of the Rubber Industry

NEWCASTLE-UPON-TYNE
"Safety and Welfare in Rubber Factories," by S. F. Smith. North Eastern Section. Eldon Grill, Grey-street, Newcastle-upon-Tyne. Mon., Dec. 2, 7 p.m.

Institution of Structural Engineers

BIRMINGHAM
"The Cement Gun," by W. J. Young. Midland Counties Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Fri., Dec. 6, 6.30 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., Dec. 6, 7 p.m.*

Pipeline Industries Guild

LONDON
"Ferrous Pipes," by Dr. J. S. Blair. Alliance Hall, Caxton-street, S.W.1. Tues., Dec. 3, 6.30 p.m.

Reinforced Concrete Association

GLASGOW
"Advantages and Limitations of Vibrators and Concrete Placing Equipment," by H. Williamson. Scottish Branch. St. Enoch Hotel, Glasgow. Tues., Dec. 3, 6.30 p.m.*

Royal Aeronautical Society

LONDON
"Engine Testing Under Simulated Icing Conditions," by O. R. Ballard and P. J. Sharp. Tues., Dec. 3, 7 p.m.

Royal United Service Institution

LONDON
"Development of Nuclear Power for Marine Purposes," by Rear-Admiral G. A. M. Wilson. Wed., Dec. 4, 3 p.m.

Society of Instrument Technology

CHELTENHAM
"Plastics as Engineering Materials," by A. Kennaway. Cheltenham Section. Rotunda, Cheltenham. Mon., Dec. 2, 7.30 p.m.

Women's Engineering Society

LONDON
Discussion on "The Radio Telescope." C.E.A. Headquarters, Winsley-street, W.1. Thurs., Dec. 5, 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1. (TATe Gallery 9371.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Packaging. Apply to Mr. H. Williams, 80 Lancaster-avenue, London, S.E.27. (GIPsy Hill 4859.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (BELgravia 6111.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 4 Kensington Palace-gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Pipeline Industries Guild, 7 Iddesleigh House, Caxton-street, London, S.W.1. (ABBey 6925.)
Reinforced Concrete Association, 94–98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal United Service Institution, Whitehall, London, S.W.1. (WHItehall 5854.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)
Women's Engineering Society, 25 Foubert's-place, London, W.1. (GERrard 5212.)

In Parliament

PRIVATE MEMBERS' BILLS

A large number of proposals for new legislation have been drawn up by private Members of Parliament during the summer recess and it was arising out of this activity that a spate of 20 private members' Bills was presented to the House of Commons in one batch last week.

As usual, the new Bills cover a wide variety of subjects, dealing with such matters as the care of children and the reduction of double death duties in certain cases, and ranging from the registration of opticians to the control of betting. They were all read formally for the first time, ordered to be printed, and will be given a second reading on certain Fridays between now and the end of March next.

One Bill, presented by an Independent Ulster Unionist, Mr. George Forrest, provides for the raising of the statutory limits attached to the damages for which shipowners and others are liable. Pleas for increasing the liabilities of the shipping lines have been raised on various occasions at question time during recent months and an informative debate is likely to take place if the Bill is read again on February 7, as proposed. Another Bill, presented by Mr. George Deer (Labour), is aimed at securing an extension to the Workmen's Compensation Acts. Its objects are to provide for the payment of allowances out of the Industrial Injuries Fund to workmen covered by these Acts.

PROTECTING NEW DESIGNS

Recognition of the need to give greater protection to the proprietors of industrial and similar designs has led Mr. Alan Green (Conservative) to sponsor a Bill for amending the Registered Designs Act, 1949.

According to existing arrangements, anything from two to six months may be required by the Patent Office, after an application has been presented, for the registration of a new design. If, during this interval, other persons make use of the design, the owners have no protection against the pirates. The new Bill, which is supported by Sir John Barlow, Bt. (Conservative), Mr. Arthur Lewis (Labour), and others, seeks to secure the protection that will accrue to proprietors from having the registration back-dated to the time of the original application. Designers of most classes of consumer goods, including many types of engineering products, especially of the small kinds, are likely to be benefited by the passing of this measure.

Another Bill, initiated by Mr. Victor Yates (Labour), is designed to implement the proposals of the Gowers committee, in so far as these recommendations affect the safety, health and welfare of persons employed in offices. Its provisions extend to arrangements in all types of offices, whether owned by local authorities, nationalised industries, the railway services, or private industry, but it does not attempt to cover conditions in shops. Captain Frederick Corfield, Conservative Member for South Gloucestershire, introduced a Bill to provide for improvements in the law relating to compensation for the compulsory acquisition of land.

TRIBUNALS OR COURTS OF INQUIRY?

The controversy as to whether or not courts of inquiry should replace arbitration tribunals for the investigation of industrial disputes was raised by Captain Richard Pilkington (Conservative). He asked the Minister of Labour and National Service for a statement of the Government's policy on the possibility of the courts replacing the present system of tribunals, and suggested, as an alternative, that the tribunals should publish the reasons for their recommendations.

Mr. Iain Macleod said that the purpose of a court of inquiry was to inquire into the causes and circumstances of a dispute and to report thereon to the Minister. A court of inquiry might make suggestions, of course, for bringing the dispute to an end, but an inquiry was no substitute for arbitration, the purpose of which was to settle the dispute by making an award. Tribunals were free to give reasons for their awards but they rarely did so, in practice.

There were arguments both ways. Tribunals often felt that if they pinpointed certain reasons for their decisions, they might add to, or re-open, the controversy which led to the arbitration proceedings. On the other hand, they might wish to draw attention to a special matter, such, for example, as in the case of the recent provincial bus disputes, when the tribunal said that the award was deliberately linked to the relative wage differential. He had welcomed that identification and would be very glad if similar action were taken on other suitable occasions.

FINES FOR MEN WHO WORK

Captain Pilkington also suggested that the Minister should consider the introduction of legislation to make unlawful the practice obtaining in certain trade unions, and in certain districts, of fining men for working longer hours.

When told by Mr. Macleod that he was aware of the considerations that the Captain had in mind, but that he did not feel that the matter was one for legislation, Captain Pilkington said he agreed that it was probably not desirable to change the law. At the same time, he asked, did not Mr. Macleod think that it was most regrettable that, at a time when greater productivity was so important to everybody, the Amalgamated Engineering Union in Sheffield should fine people who were willing to work longer hours?

In reply, Mr. Macleod took the view that when members of any association, whether trade union, political party or golf club, made rules and people did not like them, it was for the members themselves to change those rules. He did not feel that it was for the House of Commons to take action.

ENGINEERS FOR THE SERVICES

Mr. Horace King, Ph.D. (Labour), urged the Minister to grant exemption from national service to science and technology graduates entering establishments for further education, in view of the recommendations made in the recent report by Dr. Willis Jackson.

Mr. Macleod replied that he understood the recommendation in Dr. Jackson's report meant that science and engineering graduates with second-class honours degrees should be granted indefinite deferments, on the same conditions as men with first-class honours, when taking up any employment for which a science or engineering degree was required. He had received a similar proposal from the Federation of British Industries, and had referred it to his Technical Personnel Committee for its advice. Asked to bear in mind that, among men already exempted, were science graduates employed in teaching, some arts graduates engaged in teaching, and science graduates with first-class honours teaching in technical institutions, and that there was a shortage of science teachers, Mr. Macleod said that these were the reasons upon which he decided to seek the advice of his committee. It would be meeting within the next week or two to study the proposal.

Goggles in Foundries

The report of the Joint Advisory Committee on Foundry Goggles is to be published as soon as research and development work now in hand, as recommended by the committee, enables the Government to give more comprehensive and authoritative advice than is at present available. Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour, said on this subject that, whereas the committee came to the general conclusion that plastics were to be preferred to glass for use in these protective goggles, further investigations were required to provide specific recommendations as to the form of the plastics. The Government wanted to have that specific advice before the report was published. Meanwhile, he told Mr. Frank Allaun (Labour), copies of the report were being sent to interested organisations.

Workless in Contracting Industries

There were 32,500 unemployed persons on October 14, whose last jobs were in the building and civil-engineering industries, compared with 25,700 people a year earlier. During the twelve months ended in September last, according to an answer given by Mr. Iain Macleod to Mr. N. N. Dodds (Labour/Co-operative), numbers employed in these industries dropped by 31,000, and there might be some further reductions during the coming months, but this state of affairs would not necessarily be accompanied by a corresponding rise in unemployment.

Watching the Satellites

Mr. Gresham Cooke (Conservative) inquired about the steps that had been taken by the Royal Observatory at Greenwich to observe the Russian satellite launched on October 4. He was informed by Mr. Christopher Soames, Parliamentary Secretary to the Admiralty, that scientific interest in the satellite was not astronomical but geophysical. The equipment at the Royal Observatory was designed for the observations of natural celestial bodies and it could not be used for following objects moving at the speed of the satellite. Nevertheless, the Observatory had calculated the satellite's orbit and, subsequently, the rocket had been observed there with the naked eye on a number of occasions.

Damage by Sonic Booms

Replying to an inquiry by Mr. Geoffrey de Freitas (Labour) about the amount of damage done to buildings by sonic booms, Mr. George Ward, the Secretary of State for Air, said that 1,439 claims had been investigated during the last three years. The effects of sonic booms on buildings were being investigated by the Building Research Station of the Department of Scientific and Industrial Research. The inquiries included the measurement of the pressures set up by a sonic boom and of the vibrations induced by them. The information from the direct measurement of pressures was at present incomplete. The examination of buildings about which complaints had been made had showed that the actual amount of damage done, that could be ascribed solely to sonic booms, was much less than had been claimed.

Life Saving at Sea

During the past six months, Mr. Airey Neave, Joint Parliamentary Secretary to the Ministry of Transport, told Mr. Hector Hughes (Labour), five requests had been made to him to amend the provisions relating to the carrying of life-saving apparatus by merchant ships. These concerned inflatable life rafts, radar reflectors, safety clothing, chemical apparatus for de-salting water, and solar stills. The last-mentioned proposal was that solar stills should be allowed as an optional alternative to a proportion of the drinking water required to be carried in tins in inflatable life rafts.

Admiralty Organisation Inquiry

The committee set up, under the chairmanship of Sir Barclay Nihill, is conducting an investigation into the capacity of the Admiralty organisation as a whole, including arrangements outside as well as those within, for meeting the navy's material requirements. The committee is also concerned, according to information given by Mr. T. G. D. Galbraith, the Civil Lord to the Admiralty, to Mr. Percy Wells (Labour), with certain staffing problems. It is not concerned, however, with the future of the Royal Dockyards individually. The committee, Mr. Galbraith said, had recently rendered a report covering the first part of its terms of reference, and that report was now being considered. A report on the second part was expected shortly.

The Human Element

War of Nerves

The wage situation is moving slowly forward to some sort of a crisis. The Government are taking every opportunity to explain exactly what they will do, and will not do, in the effort to prevent wages increasing at the expense of the tax payer. Last week the Treasury announced that it would not accept net increases in salary bills from departments of Government. Increases must be met by economies in other ways in departmental outlays. There has been no weakening in the attitude on health officers' pay. In the private sector, the engineering operatives have been turned down in their demand for a 40-hour week—which everyone expected.

Into this situation the co-operative movement suddenly threw a gesture which may yet be of considerable importance in the wages situation. It announced last week increases in pay to date from the beginning of December for about 250,000 employees from managers to shop assistants. This probably is no more than an effort on the part of the co-operative movement to get its salaries belatedly nearer the market rate and has no significance in itself so far as the national wage situation is concerned. Nevertheless it is a chink in the employers' armour and it may yet be used as an argument by the unions in the coming round of wage negotiations.

Wages and the Dollar

In a letter to *The Times* last week, one of our leading economists, Sir Ralph Hawtrey, argued that the pound was undervalued in terms of the dollar. For this reason, " the stabilisation of the price level cannot succeed " and " industry can everywhere afford to pay higher wages." Eventually, as prices rise, the dollar value of the pound will forcibly prevent wages from rising further. But why, he asks, wait until then to work out a stable wage policy based on a correct valuation of the pound? Monetary policy could achieve this, very much to the advantage of wage earners as well as managers, and much less painfully.

Sir Ralph Hawtrey thinks that the Government have misunderstood the essentials of the present situation. They have committed themselves to a wage policy which relates wages to productivity. But who is to say what productivity means precisely and to what increases are due? How can we fairly differentiate between firms, or between industries?

Maintaining the Guild Standard

The annual report of the Engineers' Guild Limited for the year up to September, 1957, was issued last week. It tells of a year of increased activity by the guild on behalf of the profession. Possibly the largest single project of the year was the introduction of the pensions scheme last December. Since the first scheme was introduced (there have since been modifications favourable to the insured under the Finance Act, 1956) there have been 600 inquiries up to the time of the annual report. Also last year, there were discussions with the British Transport Commission on matters of professional interest on working conditions.

In the increased publicity which the guild has achieved over the year, the controversy with certain local authorities about the professional status of engineers is of outstanding interest. Several of these authorities have sought to make engineers join trade unions as a condition of employment. The latest instance has been at Edmonton.

The guild has expanded further during the year. Membership increased from 4,505 to 4,621, including a significant transfer from associate status to full membership.

Living Strenuously

The role of a doctor in industry was the subject of a stimulating and informative paper read by Unilever's principle medical officer, Dr. J. J. O'Dwyer, to the National Conference of the British Institute of Management at Bournemouth. Dr. O'Dwyer was particularly concerned with the group of people " many of whom get to the top because work is their obsession." Under the title " The Stresses and Strains of Executive Life," he attempted to define those factors which make the managing director, the chief engineer, the sales manager and other senior managers so much more likely to die of heart disease than their subordinates. Such people are, of course, subject to the same stresses and strains as everyone else, but, Dr. O'Dwyer pointed out, being more intelligent than the average and some, in consequence, more sensitive, feel these strains deeply. To three strains he attributed much of the threat to the health of our seniors: firstly, the gradual and increasing lack of family cohesion due to long and irregular hours, travel and working at home. Secondly the inability of many senior managers, particularly the older among them, " to come to terms with the social revolution of our time." Essentially this means that promotion does not bring freedom from financial worries. The levelling down in post-war Britain has been such that executives are for ever struggling to keep a balance between the high standard of living which they have worked for and expect, and diminishing net incomes. Thirdly, an increasingly complex work situation in which promotion no longer means security nor implies independence. The policy maker is largely unable to identify his own aims with those of the firm in an enlightened self-interest, and becomes increasingly pre-occupied with holding on to his personal status and the status quo.

Guessing Doesn't Pay

In a paper read during the British Institute of Management's National Conference at Bournemouth, " Automation—Its Demand on Management," Mr. J. Buckman, the general works manager of the Standard Motor Company, spoke of the difficulties and problems which faced him and his colleagues during the extensive re-mechanisation undertaken over the past year. Their experience was gained from " the recent installation of £4½ million worth of up-to-date metal-working machines."

Mr. Buckman talked mainly of the various steps which are required to introduce a new project of this magnitude. Perhaps he was being wise after the event but what he had to say about research—preliminary, transitional and corrective—seemed sound applied common sense. Two observations had a ring of the familiar about them; as well as a tinge of bitterness. They were that machine tool makers' specifications and promises are not the " scientific data " on which production quantities and costs can be accurately forecast; and that a well established system of communications between management and operators is essential.

The value of this contribution lies not so much in the light it throws on the problems brought about by the introduction of automatic production techniques, but as a case study of a very extensive change in organisation and method due to large-scale introduction of new initiative. Also, it contains an exemplary lesson concerning the importance of timing; it is best to take steps to increase productivity when demand is rising and labour is in very short supply. But note that in Mr. Buckman's view, greater use of automatic control in production processes has not changed the functions of management in the automobile industry to any marked extent, though it has greatly intensified and extended the scope and effect of decisions.

American Social Security

A great illusion of our time is that Britain indulges in social welfare to an extent much greater than most other large industrial communities. There is everywhere a tendency to an equalisation of incomes and to the provision of all basic needs in the form of insurance, pensions, subsidised housing and the like. Some countries, such as our own and the United States, are much further along than others, for example Italy and Germany, but all are travelling on the same path.

Two United States Government publications—*Social Security in the United States*, and *Collective Bargaining in the U.S.*—contain interesting evidence of what is described as " the high degree of social security now enjoyed by the American people." There, as here, social security on a national plane was a product of the slump—it began in 1935 at the instigation of President Roosevelt. Now there are old-age pensions (at the end of 1956, 9 million people were receiving 485 million dollars a month), dependants' pensions, sickness or disability insurance, public assistance, unemployment insurance and other benefits. A public health service is in being and in process of extension—in many cases health insurance is being paid by employers.

The United States have become more security conscious than any other nation. The guaranteed annual wage and the automatic annual wage increases make incomes more secure than they have ever been, and there is a tendency away from piece-work rates and commission to time rates and straight salaries. Some of this has been achieved by social pressures, and major wars are great levellers, but much is due to the collective bargaining power of the trade unions.

Moonlight in the Mines

" I dismiss the use of stop-watch methods as moonshine," said the area president of the National Union of Mineworkers in south Yorkshire last week. This reported remark followed the decision of the local executive not to co-operate with the National Coal Board in having miners trained in work study, including time and motion study.

Some time ago there was a limited use of the stop-watch at the surface to gauge the reaction, the idea being that it was useless to try out such techniques down the pits if they were not acceptable at the surface, where prejudice might be supposed to be rather less ingrained than below ground. The miners, however, will have none of it. Technically there are ways of doing work study without using watches and it may be possible to try out some of these in the coalfields —indeed the N.C.B. may have to be resigned to the development of techniques of work study of special application to the mines which dispense with the watch altogether. It will require careful preparatory work and good management, however, to use these where time studies on the spot are not allowed. Stop-watches may be moonshine, but so is prejudice—an attitude which is unlikely to bring much light into the darkness.

In referring to the conference of the British Institute of Management at Bournemouth (Human Element, November 15) we mentioned " The amalgamation with the Institute of Personnel Administration. . . ." We regret this error; the B.I.M. amalgamation was of course with the Institute of Industrial Administration.

ENGINEERING

An Illustrated Weekly Journal

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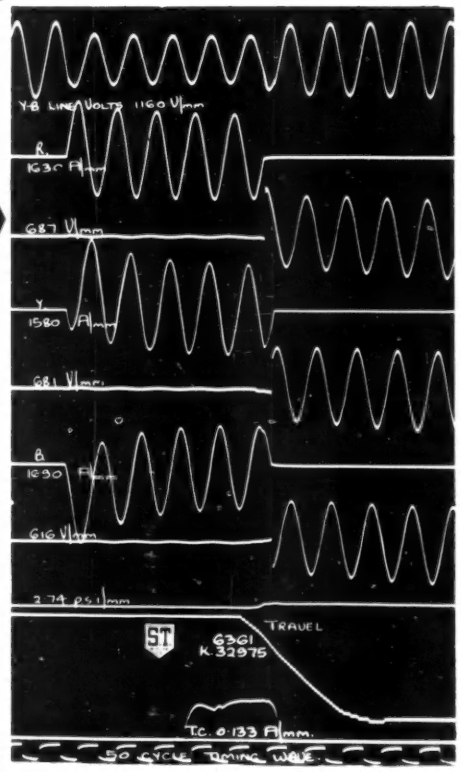
This oscillogram shows the performance of a typical Metrovick VH metal enclosed switchgear unit. Note particularly the absence of arcing on the first major peak. Switchgear of this type is ideally suited for the control of heavy industrial services or power station auxiliaries.



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